

would remain toxic. The use of an armored cap will be inadequate to reliably contain the pulp waste over the long-term at the Site.

2.5.104 Comment: The 2007 National Academies study of the effectiveness of environmental dredging was unable to conclude that dredging alone could achieve long-term risk reduction due primarily to the inability to fully remove contaminants and avoid sediment resuspension or residual contamination.

Response: *The findings of the 2007 National Academies study of the effectiveness of environmental dredging reflects the performance of environmental dredging in the “wet”, often with limited best management practices, without residuals management, and with a goal of mass removal rather than immediate achievement of risk reduction.*

As discussed in the Proposed Plan of Action, EPA and USACE indicated that a potential small release of the waste material may occur during removal activities under alternative 6N. Comments received during the Proposed Plan comment period requested that EPA consider the use of additional Best Management Practices (BMPs) to prevent or minimize the release of waste material during removal. To this end, the EPA worked with USACE to further evaluate the use of BMPs to minimize releases during remedial action. One of the BMPs proposed was the use of a cofferdam with excavation in the “dry” to prevent the re-suspension and residuals that typically result from under water dredging. It should be noted that the actual BMPs to be utilized will be determined during the Remedial Design phase after engineering assessment and evaluation. All final BMPs used as part of the remedial action will have to comply with ARARs, including the requirement that there be no discharges that exceed the Texas Surface Water Quality Standards.

In recognition of the difficulty in achieving risk reduction by environmental dredging, a BMP such as a cofferdam and sheetpile wall could be used to completely enclose the capped area for removal in the “dry” by excavation rather than “wet” dredging. Excavation in the “dry” will facilitate monitoring, testing and sampling of the final surface to achieve long-term risk reduction.

2.5.105 Comment: Often risk reduction after dredging is achieved with residuals management, for example, placement of a post-dredging cap or backfill layer. Such a residuals management layer, however, is not normally designed for stability under even modest flow conditions and is unlikely to remain in place under conditions for which the caps under Alternative 3N or 3aN are designed. Alternative 6N requires installation of a sand and armored cap to contain residuals following removal operations, so the same monitoring, maintenance and potential release mechanisms will exist for both alternatives, although it is difficult to envision that the residual containment would be designed to the same degree of protectiveness as the Alternative 3aN cap.

Response: *EPA is lowering the target concentration to 30 ng/kg for the waste pits to pursue a closure of the site without the need for a residuals cap and berms. As discussed in the Proposed Plan of Action, EPA and USACE indicated that a potential small release of the waste material may occur during removal activities under alternative 6N. Comments received during the Proposed Plan comment period requested that EPA consider the use of additional Best Management Practices (BMPs) to prevent or minimize the release of waste material during*

removal. To this end, the EPA worked with USACE to further evaluate the use of BMPs to minimize releases during remedial action. One of the BMPs proposed was the use of a cofferdam with excavation in the “dry” to prevent the re-suspension and residuals that typically result from under water dredging. It should be noted that the actual BMPs to be utilized will be determined during the Remedial Design phase after engineering assessment and evaluation. All final BMPs used as part of the remedial action will have to comply with ARARs, including the requirement that there be no discharges that exceed the Texas Surface Water Quality Standards.

Excavation prevents the formation of residuals from sedimentation and allows removal to the cleanup level by preventing the fluidization and spreading of the sediment in an uncontrolled manner. Additionally, excavation in the “dry” facilitates meeting the target depth of removal, permitting visual inspection of residuals, which may be evident by differences in color, texture and consistency. Removal in the “dry” facilitates the sampling, monitoring and testing of the site to ensure compliance since the residuals are not mobile on a dewatered site. Residuals transported by runoff would be collected in the drainage sump and removed before site closure. The target concentration for residuals will be decreased to 30 ng/kg to pursue a closure of the site without the need for a residuals cover. In practice, the dioxin concentration remaining in the sediment after removal is likely to be much lower since excess material will be removed below the target depth to ensure that the target is met.

2.5.106 Comment: The releases and residuals from the Alternative 6N cannot be predicted with the precision implied by the US Army Corps of Engineers 2016 Report and they could potentially be much greater. As noted in the US Army Corps of Engineers 2016 Report, for example, potential releases and implementation issues will be exacerbated during storm events that will occur during the construction period.

Response: *The predictions are meant to be characteristic of the proposed operations and are suitable for comparing operations or approaches and technologies. Actual releases and residuals would be a function of the actual design, equipment, scheduling, operation, site conditions and weather. To eliminate the effects of these variables, the removal will be performed in the “dry” by dewatering the site. The Remedial Design will consider these variables when scheduling and sequencing operations.*

2.5.107 Comment: Conducting the removal remedy in stages can reduce the impact of small storm events but would be unlikely to provide significant control of resuspension and residuals if a major storm event were to occur during construction.

Response: *This comment assumes removal in the wet without complete containment where water is able to be transported through the site. EPA is lowering the target concentration to 30 ng/kg for the waste pits to pursue a closure of the site without the need for a residuals cap and berms. As discussed in the Proposed Plan of Action, EPA and USACE indicated that a potential small release of the waste material may occur during removal activities under alternative 6N. Comments received during the Proposed Plan comment period requested that EPA consider the use of additional Best Management Practices (BMPs) to prevent or minimize the release of waste material during removal. To this end, the EPA worked with USACE to further evaluate the use of BMPs to minimize releases during remedial action. One of the BMPs*

proposed was the use of a cofferdam with excavation in the “dry” to prevent the re-suspension and residuals that typically result from under water dredging. It should be noted that the actual BMPs to be utilized will be determined during the Remedial Design phase after engineering assessment and evaluation. All final BMPs used as part of the remedial action will have to comply with ARARs, including the requirement that there be no discharges that exceed the Texas Surface Water Quality Standards. A variety of transportation options including barge transport will be considered during Remedial Design of the transportation and disposal components using a number of factors including costs, feasibility and implementability. EPA appreciates the offer of assistance from the surrounding communities and businesses. However, the final method of transportation and disposition will be identified in the Remedial Design phase. Removal in the “dry” eliminates the potential for resuspension and release of contaminants and contaminated water. It also prevents the formation of residuals from sedimentation and allows removal to the cleanup level by preventing the fluidization and spreading of the sediment in an uncontrolled manner. Additionally, removal in the “dry” facilitates the sampling, monitoring and testing of the Site to ensure compliance.

2.5.108 Comment: The Proposed Plan suggests that there may be negative consequences of the additional rock placement including settling or expression of waste material beyond the cap. Settling of the current cap has not led to observable negative consequences and has likely led to some consolidation and strengthening of the underlying waste material. The expression of waste material beyond the cap is highly unlikely given the observed need for gentle slopes on armoring material that will extend the cap far beyond the boundaries of the waste.

Response: *The EPA notes that the area of missing cap found by the EPA Dive Team in 2015 was caused by the armor cap sinking into the waste material and resulted in exposing dioxin at over 40,000 ng/kg to the San Jacinto River. It is possible that additional loads on the capped area may result in further sinking or movement of the underlying materials.*

2.5.109 Comment: An additional concern expressed by EPA regarding Alternative 3aN is the failure to treat Principal Threat Waste exhibiting dioxin concentration greater than 300 ng/kg (although the preferred remedy also provides no treatment of the Principal Threat Waste). EPA considers material at the Site to be Principal Threat Waste due to its toxicity and potential mobility. Mobility of the waste materials should not be of concern for Alternative 3aN since it was designed to protect against even very low probability events now and in the future. The use of an armoring rock with a median diameter of 15-inches exceeds the US Army Corps of Engineers suggested 12-inch which would be expected to be protective under the hypothetical event of maximum river discharge and a simultaneous storm surge similar to that observed with Hurricane Ike.

Response: *Capping poses concerns with long-term effectiveness/permanence from disruption from barge strikes, erosion, and channel realignment. The US Army Corps of Engineers believes that the hydrodynamic and sediment transport modeling was sufficient to establish concerns regarding the site stability. Demonstration of shear stresses sufficient to erode larger than 8-inch stone as shown in the modeling suggests that channel migration could initiate. As evidenced by the scouring during 2016 flooding, extensive armoring or hardening of the area surrounding the site would likely be needed to prevent undercutting of the cap slopes.*

The scouring could undermine the perimeter slopes and lead to slope failures, particularly in areas with steeper slopes. Even though Alternative 3aN consists of an upgraded cap, it is still subject to the uncertainties of severe floods, a dynamic river, and adequate maintenance over the centuries that the waste will remain toxic. Climate models (Knutson and others, 2010) predict an increase in the intensity of tropical cyclones and hurricanes in the Gulf, meaning greater risk of flooding and storm surges over the long time frame that the dioxin waste would remain hazardous.

The Corps of Engineers performed a more recent model simulation to investigate the performance of the upgraded cap, Alternative 3aN. The results of the Alternative 3aN modeling showed that erosion of the cap would likely occur over most of the cap during the extreme storm event modeled. This modeling considered the wave impacts from a Category 2 hurricane (Hurricane Ike), however, even stronger hurricanes capable of achieving Category 3, 4, or 5 levels are possible during the long term that the dioxin would remain toxic. The removal of the waste material will provide a long-term solution to protect the community, eliminate the potential for a release to the environment, and prevent the Site from becoming a large contaminated sediment site.

2.5.110 Comment: Partial losses of a cap would not compromise its effectiveness like partial losses to a building or even a harbor protection structure (where partial losses might expose the harbor to full storm surges).

Response: *Partial losses of the cap may result in a release of dioxin to the environment; the purpose of the cap is to prevent such releases and prevent impacts to human health and the environment.*

2.5.111 Comment: Describing a best management practice in the Proposed Plan and tagging it with if practicable, if necessary, or if feasible means that EPA does not know whether the identified best management practices will actually work or are implementable to control releases of dioxin/furans and other contaminants into the San Jacinto River.

Response: *The best management practice is identified with qualifiers because the scope of past geotechnical investigation was limited and additional pre-design investigations may be necessary to assess the feasibility of certain best management practices such as water-tight sheet pile walls. The use of a cofferdam is considered to be the most effective best management practice to control releases and residuals for complete removal of the waste sludge and contaminated sediments at the San Jacinto River Waste Pits. Cofferdams offer flexibility in construction methods and material to accommodate the local site conditions and project goals. Additionally, the cofferdam can be placed outside of the armored cap to prevent disturbance of the contaminated sediment prior to containment. Cofferdams have been constructed in similar locales for excavation and construction activities such as at the Formosa Plastics, Texas site for contaminated sediment removal, at Matagorda Bay for archeological recovery and at numerous coastal sites for construction. Removal in the “dry” was performed to control organic chemical liquid releases in the upper 1 ½ miles of the Housatonic River site using cofferdams and by-passing the river flows. Sheet pile wall cofferdams have been used in a large sediment removal in the “dry” project in the Grand Calumet River in Indiana to control organic chemical liquid*

releases. Berms have been employed to form cofferdams to control resuspension at Hooker Chemical site in New York.

2.5.112 Comment: EPA's seemingly simple and theoretical approach to remove the rock cap and geotextile is technically flawed. There is no precedent for removal of an engineered armor rock cap and the underlying geotextile. As stated by Dr. Todd Bridges, the U.S. Army's Senior Research Scientist for Environmental Science and Director of the Center for Contaminated Sediments at the Engineer Research and Development Center (ERDC) with respect to the proposed removal of the rock cap and geotextile at the Site, "It's never been done. It will result in a huge mess of turbidity, re-suspended sediments, and residuals."

Response: *The comment is based on removal in the wet where water is able to be transported through the site. To eliminate this potential exposure during removal operations, the removal would need to be performed in the "dry" by dewatering the site. The US Army Corps of Engineers agrees that the armor rock cap and underlying geotextile cannot be removed efficiently without simultaneously removing contaminated sediment.*

EPA is lowering the target concentration to 30 ng/kg for the waste pits to pursue a closure of the site without the need for a residuals cap and berms. As discussed in the Proposed Plan of Action, EPA and USACE indicated that a potential small release of the waste material may occur during removal activities under alternative 6N. Comments received during the Proposed Plan comment period requested that EPA consider the use of additional Best Management Practices (BMPs) to prevent or minimize the release of waste material during removal. To this end, the EPA worked with USACE to further evaluate the use of BMPs to minimize releases during remedial action. One of the BMPs proposed was the use of a cofferdam with excavation in the "dry" to prevent the re-suspension and residuals that typically result from under water dredging. It should be noted that the actual BMPs to be utilized will be determined during the Remedial Design phase after engineering assessment and evaluation. All final BMPs used as part of the remedial action will have to comply with ARARs, including the requirement that there be no discharges that exceed the Texas Surface Water Quality Standards. A variety of transportation options including barge transport will be considered during Remedial Design of the transportation and disposal components using a number of factors including costs, feasibility and implementability. EPA appreciates the offer of assistance from the surrounding communities and businesses. However, the final method of transportation and disposition will be identified in the Remedial Design phase

A BMP such as a cofferdam would be placed outside and surrounding the existing armored cap so as not to disturb, resuspend and release contaminated sediment during construction of the cofferdam nor complicate and interfere with armored cap removal. The armor stone would need to be disposed in a landfill with the contaminated sediment unless the stone can be washed and reused. The entire capped area will be completely encircled during removal.

2.5.113 Comment: EPA has not demonstrated an understanding of the technical challenges (e.g., underwater removal of the rock, how to peel back the rock and geotextile to install sheet pile, how to remove the geotextile from the entire site, how to pick it up without creating a large

dispersion of residuals and suspended sediments, how to remove the cap and geotextile in small sections, and how to deal with the cement used to treat and stabilize the waste in the western area) nor evaluated the environmental ramifications associated with the actual removal of the cap and geotextile.

Response: *This comment assumes removal in the wet where water is able to be transported through the site. As discussed in the Proposed Plan of Action, EPA and USACE indicated that a potential small release of the waste material may occur during removal activities under alternative 6N. Comments received during the Proposed Plan comment period requested that EPA consider the use of additional Best Management Practices (BMPs) to prevent or minimize the release of waste material during removal. To this end, the EPA worked with USACE to further evaluate the use of BMPs to minimize releases during remedial action. One of the BMPs proposed was the use of a cofferdam with excavation in the “dry” to prevent the re-suspension and residuals that typically result from under water dredging. It should be noted that the actual BMPs to be utilized will be determined during the Remedial Design phase after engineering assessment and evaluation. All final BMPs used as part of the remedial action will have to comply with ARARs, including the requirement that there be no discharges that exceed the Texas Surface Water Quality Standards.*

A BMP such as a cofferdam would be placed outside and surrounding the existing armored cap so as not to disturb, resuspended and release contaminated sediment during construction of the cofferdam nor complicate and interfere with armored cap removal. The removal operation will be developed during the Remedial Design but removal of the armored cap is likely to progress continuously with removal of the contaminated sediment. The armor stone would need to be disposed in a landfill with the contaminated sediment unless the stone can be washed and reused. The solidified sediment in the western cell would be expected to have an unconfined compressive strength of about 60 psi, comparable to the strength of a moderately stiff clay. Conventional excavating equipment should be readily able to break and remove the sediment that had been stabilized with cement during armored cap construction. Appropriate excavating equipment that can accommodate the solidified sediment should be selected during the Remedial Design.

2.5.114 Comment: The US Army Corps of Engineers estimated releases of dioxin/furans to the San Jacinto River from Alternative 6N was 2.0-2.37 grams, which is 0.34% of the total dioxins/furans to be removed from the pits. By just considering the additional releases from blocked open buckets spilling their contents, the total released to the San Jacinto River from dredging in the Northwest Area and the deep water portion of the Eastern Cell would be 32 grams, which is greater than 5% of the dioxins/furans in the pits. (Bean Consulting)

Response: *As discussed in the Proposed Plan of Action, EPA and USACE indicated that a potential small release of the waste material may occur during removal activities under alternative 6N. Comments received during the Proposed Plan comment period requested that EPA consider the use of additional Best Management Practices (BMPs) to prevent or minimize the release of waste material during removal. To this end, the EPA worked with USACE to further evaluate the use of BMPs to minimize releases during remedial action. One of the BMPs proposed was the use of a cofferdam with excavation in the “dry” to prevent the re-suspension and residuals that typically result from under water dredging. It should be noted that the actual*

BMPs to be utilized will be determined during the Remedial Design phase after engineering assessment and evaluation. All final BMPs used as part of the remedial action will have to comply with ARARs, including the requirement that there be no discharges that exceed the Texas Surface Water Quality Standards. Residual release will be minimized through the use of BMPs determined during the Remedial Design. Removal of the armored cap could have much greater impacts on resuspension and releases when removal in the wet is performed..

2.5.115 Comment: The US Army Corps of Engineers stated that Alternative 6N would "still" set back the natural recovery of the site to existing conditions by up to a decade considering the time required for design, construction and assimilation of the releases into the sediment bed below the bioactive zone (US Army Corps of Engineers 2016 page 5). Importantly, this statement does not take into account the additional significant sources of resuspended contaminants and residuals that were not adequately considered in the release calculations, i.e., releases from dredging and auxiliary vessels, geotextile removal, more dredging passes, and loss of residuals under silt curtains. If these releases were adequately addressed, how many more decades would the recovery be set back?

Response: *Greater releases than estimated would increase the time that recovery would take to achieve background contaminant concentrations when using dredging to achieve removal. As discussed in the Proposed Plan of Action, EPA and USACE indicated that a potential small release of the waste material may occur during removal activities under alternative 6N. Comments received during the Proposed Plan comment period requested that EPA consider the use of additional Best Management Practices (BMPs) to prevent or minimize the release of waste material during removal. To this end, the EPA worked with USACE to further evaluate the use of BMPs to minimize releases during remedial action. One of the BMPs proposed was the use of a cofferdam with excavation in the "dry" to prevent the re-suspension and residuals that typically result from under water dredging. It should be noted that the actual BMPs to be utilized will be determined during the Remedial Design phase after engineering assessment and evaluation. All final BMPs used as part of the remedial action will have to comply with ARARs, including the requirement that there be no discharges that exceed the Texas Surface Water Quality Standards. Excavation in the "dry" would minimize the potential release of contaminant and prevents any set back in the natural recovery of the site.*

2.5.116 Comment: Due to the ambiguous identification of the proposed best management practices and their location, the constructability of Alternative 6N cannot be determined. These are critical to understanding the technical feasibility of 6N, the extent of impacts to the San Jacinto River, and the costs. These are not areas for research and development at the Remedial Design stage. If they don't work, that would mean that Alternative 6N has been selected and justified on a faulty basis.

Response: *The EPA and US Army Corps of Engineers are aware of the challenges associated with the constructability of Alternative 6N. These challenges are not detailed in the Proposed Plan because these details will be addressed during the Remedial Design. As discussed in the Proposed Plan of Action, EPA and USACE indicated that a potential small release of the waste material may occur during removal activities under alternative 6N. Comments received during the Proposed Plan comment period requested that EPA consider the use of additional*

Best Management Practices (BMPs) to prevent or minimize the release of waste material during removal. To this end, the EPA worked with USACE to further evaluate the use of BMPs to minimize releases during remedial action. One of the BMPs proposed was the use of a cofferdam with excavation in the “dry” to prevent the re-suspension and residuals that typically result from under water dredging. It should be noted that the actual BMPs to be utilized will be determined during the Remedial Design phase after engineering assessment and evaluation. All final BMPs used as part of the remedial action will have to comply with ARARs, including the requirement that there be no discharges that exceed the Texas Surface Water Quality Standards. A cofferdam is proposed as a best management practice for implementing excavation in the “dry”. Excavation in the “dry” has been implemented at numerous sites and is therefore considered to be technically feasible. A cofferdam would be placed outside and surrounding the existing armored cap so as not to disturb, resuspend and release contaminated sediment during construction of the cofferdam nor complicate and interfere with armored cap removal. The exact placement location of the cofferdam is a design issue to be addressed during the design phase.

2.5.117 Comment: Excavation in the “dry” is a misnomer for this project. For example, excavation of the first two feet or so in the Western Cell will be in the “dry”, being above the river level. Below that level, the wastes will start to become water logged and saturated. Pumps will attempt to dewater the wastes, and keep up with the seepage through the sheet piles, but the wastes will remain saturated. The other source that will keep the wastes in a wet condition is the seepage from upwelling from below the waste pits. The depth of the wastes in the pits was estimated to be 10 feet (US Army Corps of Engineers 2016, page 99).

Response: *Excavation in the “dry” refers to removal in an unflooded state. The best management practice being considered is a cofferdam and sheetpile wall with sealed joints and the cofferdam will be filled with low permeability soil to control seepage through the cofferdam. The foundation soils include at least 10 feet of low permeability soft silt and clay immediately below the waste layer and underlain by a sand layer of similar thickness. The sand layer is underlain by more than 25 feet of hard, dense Beaumont clay. The cofferdam would be anchored in the Beaumont clay layer and would cut off the sand layer and limit the potential seepage. Upwelling through the low permeability clay layer is expected to be slow. The majority of the waste is expected to be soft and saturated. Construction activities on saturated sediments is also commonplace and techniques for working on soils with low ground strength are available such as use of swamp mats, marsh excavators, marsh cargo buggies, slide pontoons and other amphibious equipment. Similar equipment and techniques were used to place the armored cap at the San Jacinto River waste pits.*

2.5.118 Comments: Storms and flooding events are also not adequately considered in the EPA's 19-month construction period. No doubt, no crystal ball exists to predict the weather, but the US Army Corps of Engineers considered storms to be a real threat during construction. The US Army Corps of Engineers suggested that construction only occur during the offseason for hurricanes and tropical storms, i.e., when there is a lower probability of tropical storms and flooding conditions (US Army Corps of Engineers 2016, page 186). Due to the many implementation issues, the disturbed waste will be exposed for longer periods of time than contemplated by EPA.

Response: *Weather related impacts on construction duration is a common issue for all Superfund waste removal projects. The use of best management practices will minimize these impacts at the site. For example, a BMP such as a cofferdam and sheetpile wall could surround the site. A cofferdam may consist of a ringed structure constructed with two walls of sheet piles with sealed joints driven into a low permeability foundation layer and filled with soil to limit seepage. The cofferdam can be placed outside of the armored cap to prevent disturbance of the contaminated waste. The intent of the cofferdam elevation is to reduce the probability and frequency of inundation, limit the scour potential if inundated, reduce the potential volume of water to be treated from multiple dewatering events at the site, and restrict the size of delays in production. The site will remain covered with the armored cap until the cofferdam encircling the site is completed, maintaining the current level of protection at the site. The amount of waste exposed at any time will be greatly reduced by incremental removal of the armor cap and the waste material. As such, only a small sloped face of contaminated material would be exposed at any time, limiting the potential for contaminant releases. Removal operations would be stopped during hurricanes and flooding and would not resume until flooding has receded and the site has been dewatered. However, excavation is not likely to be the limiting process, but multiple excavators could be used if needed. Instead, transportation, decontamination, and the rate that the landfill is able to accept wastes are likely to be the controlling factors for construction time. A final schedule will be developed during the design phase. Weather related issues will be included in the operations plan as will appropriate contingencies.*

2.5.119 Comments: EPA reports various deficiencies in the TCRA cap, resulting from erosion, deficiencies in operation, maintenance and monitoring (OMM), and construction deficiencies. It is recommended that EPA describe in more detail why correct actions in the cap design would not sufficiently address the threats to human health and the environment under a permanent remedy for the Site.

Response: *Even though Alternative 3aN consists of an upgraded cap, it is still subject to the uncertainties of severe floods, a dynamic river, and adequate maintenance over the centuries that the waste will remain toxic. Climate models (Knutson and others, 2010) predict an increase in the intensity of tropical cyclones and hurricanes in the Gulf, meaning greater risk of flooding and storm surges over the long time frame that the dioxin waste would remain toxic. The cap design uncertainty arises from the potential increase in storm intensity by an unknown amount over the centuries that a cap would need to maintain its effectiveness. The storm intensity uncertainty, coupled with the inherent uncertainties of the models used to predict the future performance result in a highly uncertain prediction of the ability of a cap to reliably contain the waste.*

The Corps of Engineers did perform a more recent model simulation to investigate the performance of the upgraded cap, Alternative 3aN. The results of the Alternative 3aN modeling showed that erosion of the cap would likely occur over most of the cap during the extreme storm event modeled. This modeling considered the wave impacts from a Category 2 hurricane (Hurricane Ike). However, even stronger hurricanes capable of achieving Category 3, 4, or 5 levels are possible during the long term that the dioxin would remain toxic. The removal of the waste material will provide a long-term solution to protect the community, eliminate the

potential for a release to the environment, and prevent the Site from becoming a large contaminated sediment site.

2.5.120 Comment: It is recommended that EPA further describe the potential short and long-term releases associated with Alternative 4N, which proposes additional solidification, in comparison to the full removal Alternative 6N.

Response: *A further description of Alternative 4N will be included in the Record of Decision. In general, Alternative 4N would be subject to both the potential long term releases associated with a cap failure, (especially for the areas that are not stabilized), and the potential releases associated with removal of the cap.*

2.5.121 Comment: EPA summarizes the US Army Corps of Engineers Report on page 8 of the Proposed Plan, stating that the US Army Corps of Engineers recommended a 15-inch stone, but the US Army Corps of Engineers report appears to reference a 12-inch armor stone.

Response: *The US Army Corps of Engineers did discuss 12-inch armor stone in their "Evaluation of the San Jacinto Waste Pits Feasibility Study Remediation Alternatives" (2016) report, but ultimately the US Army Corps of Engineers recommended 15-inch armor stone for the Alternative 3aN upgrades as reported in the Proposed Plan.*

2.5.122 Comment: EPA's summary of Remedial Alternatives (Proposed Plan, page 21) should note that the TCRA costs for the present solidification and cap, reported to be \$9 million, are not included in estimated costs for Alternatives 1N and 2N.

Response: *The costs for the time critical removal are not included in the costs, nor were the past operation, monitoring, and maintenance cost included, because the Proposed Plan addresses the final remedy decision for the Site, and considers the future costs required to implement each of the alternatives, for comparison.*

2.5.123 Comment: The draft NRRB Recommendations is a helpful review of the record. Although EPA has responded to issues raised in the NRRB Recommendations in its Proposed Plan, it is recommended that EPA expand its response to the statement made in the NRRB Recommendations, Remedy Effectiveness, page 11 that treatment alternatives have not been sufficiently evaluated. While EPA notes that the EPA Feasibility Study addresses solidification in Alternative 4N, it is recommended that EPA develop the record to more thoroughly support its rejection of the possibility of solidifying more waste as a permanent remedy. Solidified waste would be far less susceptible to the flood events for which EPA expresses concerns for alternatives in which wastes are left on the Site.

Response: *The solidified areas in Alternative 4N are less susceptible to flood events, however, removal of the armor cap required to perform the solidification would expose the waste material to the same potential releases as the other alternatives that include removal of the cap. The areas that are outside of the solidified area would still be subject to the same long term uncertainty associated with cap stability as the other capping alternatives. The Record of Decision will describe the considerations for Alternative 4N.*

2.5.124 Comment: The Final US Army Corps of Engineers Report pre-dates the final EPA Feasibility Study and the final US Army Corps of Engineers Review did not include review of the final EPA Feasibility Study analyses. It would be helpful if EPA could make a determination with respect to the potential effectiveness of specific recommendations made in the US Army Corps of Engineers Review for improvements of the TCRA cap or other aspects of possible remedies in its additional analyses of removal alternatives. In other words, if proposed modifications were made to the alternatives (e.g. as a deeper cap with larger stone), would EPA's determination with respect to the Proposed plan remain the same? (PHA/HDR)

Response: *EPA considered the proposed modifications, which were included in Alternative 3aN. The Corps of Engineers performed a more recent model simulation to investigate the performance of the upgraded cap, Alternative 3aN. The results of the Alternative 3aN modeling showed that erosion of the cap would most likely occur over most of the cap during the extreme storm event modeled. This modeling considered the wave impacts from a Category 2 hurricane (Hurricane Ike), however, even stronger hurricanes capable of achieving Category 3, 4, or 5 levels are possible during the long term that the dioxin would remain toxic. The use of an armored cap will be inadequate to reliably contain the pulp waste over the long-term at the Site. EPA has selected Alternative 6N using the nine CERCLA remedy selection criteria as described in the Record of Decision.*

2.5.125 Comment: Both the US Army Corps of Engineers models and the Anchor QEA models use vertically mixed assumptions with no stratification of flow. This is a serious limitation of the models being used to simulate sediment transport. An analysis to demonstrate whether or not the well-mixed circulation models used are appropriate and reliable for this sediment transport application is advisable.

Response: *The US Army Corps of Engineers report discussed the model assumption regarding stratification and found that the using a depth average mode, as did Anchor QEA (AQ), would have negligible impact on the predicted sediment transport during a severe event. As stated in the report:*

"Due to the lack of vertical salinity data to be able to quantify the degree of salinity-induced stratification and the combination of hydrologic conditions and tidal flows during which at least partially stratified flows occur in the SJR estuary, it was decided to run LTFATE in the depth-average mode like AQ did with their models. Thus, both models assumed that the San Jacinto River (SJR) estuary was well mixed, so it was not possible to quantify the impact of this assumption. This assumption is thought to have negligible impact on the predicted sediment transport during a severe event such as a flood or storm surge because the combined energy from the waves and wind-, river- and tide-generated flows would be more than sufficient to vertically mix the water column."

2.5.126 Comment: As noted in previously submitted comments, neither the EPA Feasibility Study nor the US Army Corps of Engineers Report has noted the importance of bottom conditions on sediment stability or potential for remediation. It is recommended that EPA consider bottom conditions and their impacts on removal effectiveness and cost.

Response: *The US Army Corps of Engineers report discussed the bottom conditions and found that the bottom assumption did not have a significant impact on the results obtained by AQ's models. According to the report:*

"Use of hard bottom in the Houston Ship Channel (HSC) and in the upper reach of the SJR: The effect of this assumption in AQ's model framework was tested by determining the differences in the composition and thickness of the sediment bed at the SJR Site as predicted by AQ's models and LTFATE in which a hard bottom was not assumed in these two waterways. The differences were within the range of uncertainty associated with these models. The uncertainty associated with the limited sediment data in these waterways that were used to specify the sediment bed properties in LTFATE was included in this analysis. As a result, this assumption was not found to have a significant impact on the results obtained by AQ's models."

2.5.127 Comment: It is recommended that a pre-design investigation (PDI) be conducted during the remedial design for each of the treatment or removal alternatives (Alternatives 4N-6). This is important for the northern impoundment, to confirm the physical nature of sediments, condition of the Site (topography/bathymetry), and extent of constituents of concern (COCs) in sediment/soil exceeding PRGs. The PDI would provide recent information for the remedial design phase, such as if contaminant levels in surface sediment and soil have been affected by land use such as the installation of new upland asphalt and local dredging) or weather events such as flooding or alterations in channel geometry, which may have spread or incidentally contained contamination. The MNR periodic sampling program can also be refined during the PDI. ICs, such as fencing, signage, and buoys and BMPs, such as erosion control, silt curtains, and storm water pollution protection associated with the selected remedy, can also be more fully scoped during the PDI.

Response: *An investigation during the Remedial Design is anticipated to clarify the various design factors associated with implementation of Alternative 6N. The current condition of the Sand Separation Area and the ground water will also be assessed during the design phase. However, the Remedial Investigation has already determined the nature and extent of the contamination at the Site and there are no plans to repeat this. Topographic and bathymetric surveys are being conducted on a quarterly basis as a part of the ongoing quarterly Site inspections, and these surveys will continue.*

2.5.128 Comment: EPA asserts that sonar tests in a 130-foot section south of the I-10 Bridge located adjacent to the Site found about 10 to 12-feet of erosion from the bottom of the river bed. Channel scour downstream from bridges (such as that observed downstream of the I-10 bridge as a result of the 1994 flood) or other hard structures is not indicative of scour processes that will be operative at the Northern impoundments in the future, unless a bridge is built immediately upstream. Sonar examinations of the riverbed in the vicinity of the Interstate 10 crossing after the 1994 flood are described by NTSB (1996): "The Texas Department of Transportation evaluated the extent of scour around the substructure of critical sections of the two Interstate 10 bridges (east- and west-bound). The results of the sonar tests performed on October 21-22, 1994, documented 12 locations in the main channel for distances up to 130 feet south of the east-bound

Interstate 10 bridge." During this extreme event, scour was limited to a region in the main channel 130 ft south (downstream) from the east-bound bridge. Scour was not reported upstream from the crossing, between the bridges or outside the main channel. The Northern and Southern Impoundments were not scoured during the 1994 flood, despite the 10-12 ft of scour in the main channel downstream from the bridge and the fact that the Northern Impoundments were not capped at the time. The peninsula containing the Southern Impoundment is immediately downstream from the Interstate 10 crossing, but it would be impacted by bridge scour only in the event of a major realignment of the San Jacinto River main channel. As noted above, that channel has been stable and nearly static for a century and exhibits characteristics similar to stable rivers found elsewhere. Such a major realignment would be highly unlikely.

Response: *EPA agrees that a major realignment of the San Jacinto River channel would be unlikely. However, about 8-feet of riverbed scour along the eastern side of the site was discovered following the flooding in 2016, which raises concerns regarding the potential for long-term undermining of a portion of the cap. The extent of scouring at or near the waste pits during the 1994 flood is also an unknown, as no measurements were made in this area. These factors contribute to uncertainty in long-term performance.*

2.5.129 Comment: EPA asserts that changes to the site (i.e., loss of land at the waste pits site due to erosion and subsidence) will likely continue in the future. As noted above, the major driver of historical land loss at the Site was subsidence, which has been arrested by institutional controls such as those on groundwater extraction. Additional historical land loss was due to sand mining and in-channel dredging, which are now also restricted or banned in this area. It follows that land loss due to these factors should not continue in the future unless the driving factors are re-activated. At any rate, scientific data and tools are available to quantify risk regarding future morphologic changes impacting the Site (Hayter et al. 2014).

Response: *EPA agrees that much of the changes in elevation of the site that occurred previously have been arrested by institutional controls (restrictions on ground water pumping); although past capping and potential future capping may induce additional subsidence or slope stability concerns in some sections of the site. Additionally, diverting flow around the waste pits may have resulted in scour along the eastern side of the site during flooding in 2016. Additional armoring and slope/toe protection could provide additional protection; however, long-term monitoring and maintenance would be required. The extent of scouring at or near the waste pits during the 1994 flood is an unknown, as no measurements were made in this area. This contributes to uncertainty in long-term performance. The history of erosion of the San Jacinto River is pointed out in the National Transportation Safety Board's report (PB96-917004, NTSB/SIR-96/04) on the October 1994 San Jacinto River flooding; the NTSB report stated:*

"The flooding caused major soil erosion in the flood plain and river channel, including the creation of water channels outside the San Jacinto River bed. The flood waters scoured the riverbed and banks, destabilized roads and bridges, and inundated area homes. The largest new channel (approximately 510 feet wide and 15 feet deep) was created when the river cut through the Banana Bend oxbow just west of the Rio Villa Park subdivision. A second major channel cut through Banana Bend just north of the

channel through the oxbow. Both these channels cut through areas where sand mining had been performed previously.”

2.5.130 Comment: EPA asserts that Corps (Hayter et al. 2016) models (and any existing sediment transport model) cannot simulate river channel changes due to bank erosion, shoreline breaches, etc. during a high flow event caused by a major flood or hurricane. Therefore, the model predictions should be considered as having a very limited long-term reliability. Models are developed to evaluate specific situations or answer specific questions. Models themselves do not represent predictions; however, interpretations of model output can be used to predict future outcomes. Models can also be used to simulate a hypothetical scenario in order to evaluate a possible future state. Model uncertainty can be evaluated and quantified. As noted in the Proposed Plan, the Corps' hydrodynamic simulation model (Hayter et al. 2016) does not predict lateral movement or avulsion of the channel. Accordingly, the 2D hydrodynamic models (Hayter et al. 2016, AQ 2012) have not been used to evaluate potential larger scale river processes such as localized bank erosion, channel migration, or avulsion. To date, the models have been used to answer specific questions related to conditions directly adjacent to the cap. However, notwithstanding their limitations, these and similar models can quantify shear stresses impinging on the Northern and Southern Impoundments under "worst-case" extreme events (or more frequent) events. Evaluation of these stresses in light of critical stresses needed to erode the channel boundaries and floodplains can give an indication of the potential for channel migration or avulsion to initiate. Such an evaluation should consider reaches up- and downstream from the Site. In fact, models developed by Hayter et al. (2016) in support of the Proposed Plan might have been used to perform such an analysis if they captured stresses on the floodplain during overbank flow conditions. However, the work plan presented by Hayter et al. (2016), as requested by the EPA, did not include this task. The current version of HEC RAS 5.0 includes the USDA-ARS Bank Stability and Toe Erosion Model (BSTEM). Although it cannot simulate large-scale channel change, it can simulate bank erosion. This model could have been used to examine bank erosion rates and erosion potential under various scenarios. Recently-developed, "morphodynamic" simulation models (e.g., Langendoen et al. 2015 and 2016) simulate lateral channel migration and predict future channel alignments. Thus, contrary to EPA's assertion, simulation of avulsions (cutoffs) and subsequent channel response would have been possible.

Response: *The US Army Corps of Engineers did not attempt to perform morphodynamic simulations during its modeling of cap stability and erosion. The US Army Corps of Engineers found that the hydrodynamic and sediment transport modeling was sufficient to establish concerns regarding the site stability. Demonstration of shear stresses sufficient to erode larger than 8-inch stone as shown in the modeling was sufficient to indicate the potential for channel migration to initiate.*

2.5.131 Comment: EPA asserts that future storm intensity and flooding may be even more intense due to climate change, sea level rise, and continued urban development. Greater submergence due to sea level rise may further reduce hydraulic loads during the most extreme events. The Northern Impoundments' location just upstream of the I-10 crossing and rising sea level will place it under backwater conditions and in a depositional rather than erosional environment for the most extreme events. In fact, considering a wide range of events, the Site is already depositional. Hayter et al. (2016) found that net average long-term sedimentation rate

averaged over the area of the existing cap is 1.3 cm/yr.± 0.8 cm/yr. Similar findings were reported by AQ (2012). It is assumed that as additional information becomes available about storm intensity and hydraulic loadings under future climate and sea level scenarios, these data could provide a basis for quantitative analysis. If appropriate engineering analyses indicate potential for unacceptable hydraulic loading on the Impoundments or river channel movement over the period of interest, there are structural measures (river training structures such as groins, spurs, jetties, revetments or bank protection structures) that could be designed, in accordance with standard guidance and with appropriate factors of safety, to address such conditions.

Response: *Greater storm intensity would lead to larger impacts from waves, particularly in shallow locales. While the site is net depositional as a whole, specific points are not; localized scour of about 8-feet has been observed adjacent to the cap. Structural measures such as groins, spurs, jetties, revetments, or bank protection structures would be subject to the same uncertainties as an armored cap, would increase the construction costs related to the capping alternatives, and would need to be monitored and maintained, as well as the site.*

Climate models (Knutson and others, 2010) predict an increase in the intensity of tropical cyclones and hurricanes in the Gulf. The Corps of Engineers performed a more recent model simulation to investigate the performance of the upgraded cap, Alternative 3aN. The results of the Alternative 3aN modeling showed that erosion of the cap would most likely occur over most of the cap during the extreme storm event modeled. This modeling considered the wave impacts from a Category 2 hurricane (Hurricane Ike), however, even stronger hurricanes capable of achieving Category 3, 4, or 5 levels are possible during the long term that the dioxin would remain toxic. The use of an armored cap will be inadequate to reliably contain the pulp waste over the long-term at the Site. The removal of the waste material will provide a long-term solution to protect the community, eliminate the potential for a release to the environment, and prevent the Site from becoming a large contaminated sediment site.

2.5.132 Comment: The Final Interim Feasibility Study and Proposed Plan reflect a clear bias in Region 6 against containment as an effective remedy approach. Alternative 3aN was not selected as the preferred alternative based on EPA concerns over an ultra-extreme flow condition, based on a 500-year reliability benchmark. The use of a 500-year event is extreme and is inconsistent with EPA technical guidance for capping.

Response: *EPA does not agree that ultra-extreme flow conditions were used to assess the San Jacinto site. Technical guidance does not provide a specific design or evaluation criteria for flood return period, but rather states that it should be appropriate for the risk posed by a failure. For comparison purposes, the guidance states that the design life for a bridge or dam is 50 years and that the ability to predict forces or conditions for events with a return period greater than 100 years is restricted by the available data from historic records. However, timeframes of hundreds of years have been considered for calculations of contaminant flux and adsorption. Additionally, nuclear waste disposal facilities are designed for tens of thousands of years. Again, the required permanence is dependent on the risk posed. The waste pits site poses considerable uncertainty due to the frequency of flooding and tropical storms. The flood rates used to assess the San Jacinto waste pits are not unusual for the location of the site; the conditions modeled in the August 2016 US Army Corps of Engineers Report resulted in a river flow rate of 390,000*

cubic feet per second, which is only 8 percent greater than the 360,000 cubic feet per second flow rate reported during the October 1994 flood. Further, there were two other San Jacinto River floods during the 20th Century of greater intensity than the 1994 flood based on the Sheldon river gauge station (flood stage as follows: 32.90-feet on May 1, 1929; 31.50-feet on November 16, 1940 compared to 27.09-feet on October 19, 1994). Finally, the recent flooding associated with Hurricane Harvey resulted in a 500-year flood in the San Jacinto River based on Harris County's Flood Warning System.

The Corps of Engineers performed a more recent model simulation to investigate the performance of the upgraded cap, Alternative 3aN. The results of the Alternative 3aN modeling showed that erosion of the cap would most likely occur over most of the cap during the extreme storm event modeled. This modeling considered the wave impacts from a Category 2 hurricane (Hurricane Ike), however, even stronger hurricanes capable of achieving Category 3, 4, or 5 levels are possible during the long term that the dioxin would remain toxic. The use of an armored cap will be inadequate to reliably contain the pulp waste over the long-term at the Site.

2.5.133 Comment: EPA dismisses the fact that a containment remedy approach can be designed and implemented at this Site to provide secure and permanent isolation of the waste.

***Response:** A containment remedy approach can be designed and implemented at this Site. However, containment presents a number of challenges as well as monitoring, maintenance and repair. Analysis of the site shows significant potential for erosion and considerable uncertainty in the range of potential shear stresses that the site will experience.*

2.5.134 Comment: Alternative 3aN contains provisions that would ensure stability against very extreme events. This Alternative was essentially dismissed by EPA for the same reasons they rejected Alternative 3N, even though 3aN is a significantly more robust containment alternative.

***Response:** Containment also presents a number of challenges as well as monitoring, maintenance and repair. Analysis of the site shows significant potential for erosion and considerable uncertainty in the range of potential shear stresses that the site will experience. The Corps of Engineers performed a more recent model simulation to investigate the performance of the upgraded cap, Alternative 3aN. The results of the Alternative 3aN modeling showed that erosion of the cap would likely occur over most of the cap during the extreme storm event modeled. This modeling considered the wave impacts from a Category 2 hurricane (Hurricane Ike). However, even stronger hurricanes capable of achieving Category 3, 4, or 5 levels are possible during the long term that the dioxin would remain toxic. The removal of the waste material will provide a long-term solution to protect the community, eliminate the potential for a release to the environment, and prevent the Site from becoming a large contaminated sediment site.*

2.5.135 Comment: The Proposed Plan indicates that the preferred remedy was selected based on the Final Interim Feasibility Study as supported by the US Army Corps of Engineers Report. But, the details on long term effectiveness and implementability for the alternatives in both the Final Interim Feasibility Study and Proposed Plan were selectively cited from the US Army Corps of Engineers Report to support a removal alternative. In plain language, the Proposed Plan

cherry picked statements from the US Army Corps of Engineers Report to support removal, while largely ignoring considerations in the US Army Corps of Engineers Report that clearly supported a containment alternative.

Response: *The US Army Corps of Engineers report contains information on the shortcomings and strengths of all of the alternatives without providing a recommendation or preference for the selection of an alternative. Capping would yield very low short-term releases while leaving the potential for failure under extreme events or stream bed morphological changes. Removal could also yield very low short-term releases under favorable construction conditions with the most stringent best management practices and would eliminate the potential for failure in the future. Removal with less than the most stringent best management practices would likely yield considerable short-term releases.*

As discussed in the Proposed Plan of Action, EPA and USACE indicated that a potential small release of the waste material may occur during removal activities under alternative 6N. Comments received during the Proposed Plan comment period requested that EPA consider the use of additional Best Management Practices (BMPs) to prevent or minimize the release of waste material during removal. To this end, the EPA worked with USACE to further evaluate the use of BMPs to minimize releases during remedial action. One of the BMPs proposed was the use of a cofferdam with excavation in the “dry” to prevent the re-suspension and residuals that typically result from under water dredging. It should be noted that the actual BMPs to be utilized will be determined during the Remedial Design phase after engineering assessment and evaluation. All final BMPs used as part of the remedial action will have to comply with ARARs, including the requirement that there be no discharges that exceed the Texas Surface Water Quality Standards.

2.5.136 Comment: There is no precedent for a remedy similar to Alternative 6N that involves de-construction of a secure containment and subsequent removal and transport of hazardous waste under these site conditions. The existing Time Critical Removal Action cap has soundly contained the waste since its construction. Repairs made to the existing cap have been minor and appear to be consistent with either flaws during the construction of the cap or a barge strike. There have been no documented releases of dioxin from the containment now in place.

Response: *The existing temporary cap was constructed as an interim measure to stabilize the waste pits while a final remedy could be developed. While the waste has been contained for the five years that the temporary cap has been in place, the cap has undergone a number of repairs that shows some of the weaknesses of containment. First, repairs were made on the western berm due to sloughing of the armor stone. Second, a 400 to 500-sq feet section of the cap in the Northwestern Area was repaired due to a failure that appeared to be caused by a bearing capacity failure from a poor filter layer and soft waste materials. Third, numerous locations in the Eastern Cell were repaired because the geotextile was exposed from apparent shifting or movement of the armor cap. Lastly, an area of scour nearly adjacent to the Eastern Cell was filled and armored from the edge of the cap to the outer limit of the scour hole. Consequently, the temporary cap appears to be less than secure containment.*

2.5.137 Comment: The comparison of Alternatives 3aN and 6N was developed on an inequitable basis. EPA's comparison of alternatives was pre-disposed toward removal as a remedy approach

and so inequitably exaggerated the disadvantages of a containment approach and dismissed the disadvantages of the removal approach.

Response: *The Record of Decision evaluated the remedial alternatives against the nine criteria. Based on the evaluation of alternatives the ROD selected alternative 6N as the remedy.*

As discussed in the ROD, EPA considered several options for contaminated materials. EPA selected a remedy that includes removal of contaminated materials above cleanup levels for the waste impoundments and MNR for the lower contamination level in the Sand Separation Area for the following reasons:

- *The material is highly toxic and under conditions in the San Jacinto River may be highly mobile and therefore is considered a Principal Threat Waste.*
- *The location of materials, either partially submerged within the San Jacinto River (northern impoundments) or on a small peninsula on the San Jacinto River (southern impoundment), result in limited ability to treat the waste in place without the threat of a release during the remedial action.*
- *The area has a high threat of repeated storm surges and flooding from hurricanes and tropical storms, which if the material was left in place, could result in a release of hazardous substances.*
- *Surface water sampling conducted in July 2016 indicated that tetra-dioxin and tetra-furan both more than tripled going over the cap. Removal of the source material will prevent this increase.*
- *Performing the dioxin removal using Best Management Practices, as determined during the Remedial Design in consultation with the U.S. Army Corps of Engineers and TCEQ, will reduce the short-term impacts and prevent any material release during the removal.*
- *Removal of the source waste material in the impoundments will eliminate the potential for a future release to the environment, which is a long-term benefit that outweighs the cost of removal. Dioxin is very persistent in the environment and is expected to remain toxic for a long time. Any cleanup approach involving capping would have to reliably achieve containment in perpetuity. Given that the Site is partially submerged in a river subject to extreme floods and hurricanes, containment is not a reliable solution for the Site.*
- *Based on historical performance of the temporary cap and surrounding area, concerns remain regarding past damage to the cap, the underwater exposure of dioxin wastes that occurred in 2015, and the sediment erosion adjacent to the capped area. The potential release and transport of the dioxin over the long-term would further impact ecological and human receptors. The long-term performance of the cap as well as the efficacy of maintenance for hundreds of years into the future is uncertain.*

For all of these factors, the Selected Remedy provides greater permanence in comparison to other alternatives. Less costly alternatives rely on remedies that have a higher chance of failure

by leaving Principal Threat Waste source materials in the river, resulting in greater uncertainty as to their long-term effectiveness.

2.5.138 Comment: Alternative 3aN holds significant advantages over Alternative 6N since it has no short-term impacts, a lower risk of a catastrophic release of dioxin, and no implementability issues.

***Response:** EPA disagrees that Alternative 3aN has a lower risk of a release of dioxin, and no implementability issues. Capping poses greater risk of a release of dioxin from erosion, scouring adjacent to the cap and channel realignment than from removal within a BMP such as a cofferdam. Capping also has implementability issues with the filter layer and slope stability in the Northwestern Area, as well as bearing capacity of the waste material to allow greater thicknesses and size of armor stone.*

The Corps of Engineers performed a more recent model simulation to investigate the performance of the upgraded cap, Alternative 3aN. The results of the Alternative 3aN modeling showed that erosion of the cap would likely occur over most of the cap during the extreme storm event modeled. This modeling considered the wave impacts from a Category 2 hurricane (Hurricane Ike). However, even stronger hurricanes capable of achieving Category 3, 4, or 5 levels are possible during the long term that the dioxin would remain toxic. The removal of the waste material will provide a long-term solution to protect the community, eliminate the potential for a release to the environment, and prevent the Site from becoming a large contaminated sediment site.

2.5.139 Comment: Alternative 3aN would entail modification of the current cap to meet the low probability barge strike and ultra-extreme storm and flow events described previously. This would involve placement of at least 24 inches of armoring material with a median diameter of 15 inches (which exceeds the US Army Corps of Engineers recommended median of 12 inches) as well as pilings to protect against barge strikes. This alternative involves enhancing the existing armored cap and would not involve disturbance of the underlying waste. It would be easily constructed, and there should be no associated release of waste materials. The remedy is expected to require 15 months to implement according to the Final Interim Feasibility Study and Proposed Plan prepared by EPA. During this period, however, the Northern Impoundments at the Site would be protected by armoring that is at least equivalent to the current armoring which the US Army Corps of Engineers suggests has effectively contained contaminants over the past 6 years despite small areas of the cap that have required maintenance. The Proposed Plan suggests that there may be negative consequences of the additional rock placement including settling or expression of waste material beyond the cap. Settling of the current cap has not led to observable negative consequences and has likely led to some consolidation and strengthening of the underlying waste material. The expression of waste material beyond the cap is highly unlikely given the observed need for gentle slopes on armoring material that will extend the cap far beyond the boundaries of the waste.

***Response:** Placement of a thicker cap poses uncertainty and difficulties, particularly in the Northwestern Area. A 400 to 500-sq foot section of the cap in the Northwestern Area was repaired due to a failure that was apparently caused by a bearing capacity failure from a poor*

filter layer and soft waste materials. Greater thicknesses and size of armor stone increase the potential for additional failure in this area. Additionally, the slope in the Northwestern Area is steep and susceptible to slope failure with the additional loadings from a much thicker armored cap. Considerable construction difficulties were encountered in placing the temporary cap in this area and additional difficulties should be expected from construction of Alternative 3aN. The slope cannot be readily flattened to a gentle slope of 1:3 or 1:5 without adding a very large quantity of material. Regarding the US Army Corps of Engineers recommendations for larger rock for Alternative 3aN, the US Army Corps of Engineers did consider 12-inch rock in their report (2016). However, the USAGE ultimately recommended the use of a larger 15-inch rock.

2.5.140 Comment: Any effect of future storm events and potential climatic changes, expressed as a concern by EPA, will push the river toward adapting to future flows by erosion of the weakest portions of the river, namely the soft, fine-grained sediments and banks, rather than the highly armored cap structure. One could envision a situation, should a hypothetical event of maximum discharge and Hurricane Ike occurred simultaneously, that the Alternative 3aN cap would be the only engineered structure still largely in place along the San Jacinto River. In addition, partial losses of a cap would not compromise its effectiveness like partial losses to a building or even a harbor protection structure (where partial losses might expose the harbor to full storm surges). Failures of such structures generally occur not through erosion of a cap but by undermining of the structure through erosion of the softer material underneath. This is avoided in the proposed cap by extending the cap with modest slope well beyond the edges of the sediment desired to be contained.

***Response:** EPA does not agree that partial losses of a cap would not compromise its effectiveness because partial losses may result in releases of toxic dioxin to the environment. There will be locations on or adjacent to the cap that will be subjected to much greater shear stresses due to site geometries and convergence of flow around or over the site. As evidenced by localized scouring along the eastern edge of the East Cell during 2016 flooding, extensive armoring or hardening of the area surrounding the site would likely be needed to prevent undercutting of the cap slopes. The scouring could undermine the perimeter slopes and lead to slope failures, particularly in areas with steeper slopes.*

The Corps of Engineers performed a more recent model simulation to investigate the performance of the upgraded cap, Alternative 3aN. The results of the Alternative 3aN modeling showed that erosion of the cap would likely occur over most of the cap during the extreme storm event modeled. This modeling considered the wave impacts from a Category 2 hurricane (Hurricane Ike). However, even stronger hurricanes capable of achieving Category 3, 4, or 5 levels are possible during the long term that the dioxin would remain toxic. The removal of the waste material will provide a long-term solution to protect the community, eliminate the potential for a release to the environment, and prevent the Site from becoming a large contaminated sediment site.

2.5.141 Comment: Digging up the waste and removing it will re-suspend the waste in the process. The Proposed Plan discounts the significant releases that the U.S. Army Corps of Engineers concludes will result from Alternative 6N, even with the use of enhanced Best Management Practices (BMPs). Some releases are inevitable despite use of BMPs and

significant releases are likely to occur during heavy rain events or other storms that have been documented to occur locally at a regular frequency. In fact, the US Army Corps of Engineers Report notes that contaminant mobilization from resuspension is expected to release 400,000 times as much contaminants as currently occurs with the intact cap and possibly five times higher than that if a flood event occurs.

Response: *This comment assumes removal in the wet where water is able to be transported through the site. As discussed in the Proposed Plan of Action, EPA and USACE indicated that a potential small release of the waste material may occur during removal activities under alternative 6N. Comments received during the Proposed Plan comment period requested that EPA consider the use of additional Best Management Practices (BMPs) to prevent or minimize the release of waste material during removal. To this end, the EPA worked with USACE to further evaluate the use of BMPs to minimize releases during remedial action. One of the BMPs proposed was the use of a cofferdam with excavation in the “dry” to prevent the re-suspension and residuals that typically result from under water dredging. It should be noted that the actual BMPs to be utilized will be determined during the Remedial Design phase after engineering assessment and evaluation. All final BMPs used as part of the remedial action will have to comply with ARARs, including the requirement that there be no discharges that exceed the Texas Surface Water Quality Standards. Consequently, the remedial action for the Site would need to include a BMP such as a cofferdam completely surrounding the Site. The cofferdam may consist of a ringed structure constructed with two walls of sheet piles with sealed joints driven into a low permeability foundation layer and filled with soil to limit seepage. Portions of the sediment at the base of the cofferdam would be armored to prevent erosion at the base of the outer wall. Additionally, the cofferdam must be of sufficient height to prevent overtopping from most flooding events. All of the water pumped from the site, including site water, storm water, wash water and seepage, would be treated prior to discharge at the site. Removal in the “dry” eliminates the potential for resuspension and release of contaminants and contaminated water. It also prevents the formation of residuals from sedimentation and allows removal to the cleanup level by preventing the fluidization and spreading of the sediment in an uncontrolled manner. Additionally, removal in the “dry” facilitates the sampling, monitoring and testing of the site to ensure compliance.*

2.5.142 Comment: Alternative 6N is acknowledged by EPA to result in short term releases of dioxin during implementation. Under the selected removal option potential exposure to the contaminants of concern will be 4,000 times greater than with a secure closure in place.

Response: *This comment assumes removal in the wet where water is able to be transported through the site. As discussed in the Proposed Plan of Action, EPA and USACE indicated that a potential small release of the waste material may occur during removal activities under alternative 6N. Comments received during the Proposed Plan comment period requested that EPA consider the use of additional Best Management Practices (BMPs) to prevent or minimize the release of waste material during removal. To this end, the EPA worked with USACE to further evaluate the use of BMPs to minimize releases during remedial action. One of the BMPs proposed was the use of a cofferdam with excavation in the “dry” to prevent the re-suspension and residuals that typically result from under water dredging. It should be noted that the actual BMPs to be utilized will be determined during the Remedial Design phase*

after engineering assessment and evaluation. All final BMPs used as part of the remedial action will have to comply with ARARs, including the requirement that there be no discharges that exceed the Texas Surface Water Quality Standards.. Removal in the “dry” eliminates short-term releases of contaminants and will perform comparably to secure containment in place without the potential of future cap failures.

2.5.143 Comment: The US Army Corps of Engineers raised issues related to implementability of Alternative 6N that were dismissed by EPA by a hand wave mention of Best Management Practices (BMPs). EPA has not adequately identified and evaluated the implementation challenges associated with Alternative 6N. To assess whether the project is practicably constructible and whether EPA's cost estimate and schedule reflect the potential complexity and challenges associated with its implementation, much more information is needed on best management practices, including descriptions of where proposed sheet piles will be installed. In general, Alternative 6N is a very inefficient remedy. It has a much higher cost, much higher short-term risk, significant implementation issues, and longer construction time.

Response: *EPA and US Army Corps of Engineers are aware of these challenges associated with Alternative 6N. These challenges are not detailed in the Proposed Plan because these details will be addressed during the Remedial Design. As discussed in the Proposed Plan of Action, EPA and USACE indicated that a potential small release of the waste material may occur during removal activities under alternative 6N. Comments received during the Proposed Plan comment period requested that EPA consider the use of additional Best Management Practices (BMPs) to prevent or minimize the release of waste material during removal. To this end, the EPA worked with USACE to further evaluate the use of BMPs to minimize releases during remedial action. One of the BMPs proposed was the use of a cofferdam with excavation in the “dry” to prevent the re-suspension and residuals that typically result from under water dredging. It should be noted that the actual BMPs to be utilized will be determined during the Remedial Design phase after engineering assessment and evaluation. All final BMPs used as part of the remedial action will have to comply with ARARs, including the requirement that there be no discharges that exceed the Texas Surface Water Quality Standards. A cofferdam is considered as a best management practice for implementing excavation in the “dry”. The cofferdam would be placed outside and surrounding the existing armored cap so as not to disturb, resuspend and release contaminated sediment during construction nor complicate and interfere with armored cap removal. The foundation sediments outside of the boundaries of the armored cap may have greater strength and stability than the waste sludge which would further investigated in pre-design. The exact placement location of the cofferdam is a design issue that would consider foundation subsurface conditions, slopes, removal depths, potential for slumping and offset requirements. Refined estimates of costs and construction times will be developed during the Remedial Design.*

2.5.144 Comment: The result of EPA's "to be determined later" approach to best management practices and inadequate assessment of resuspension and residuals is a fundamentally flawed assessment of risks and prediction of the short and long term impacts of Alternative 6N.

Response: *The best management practice is identified with qualifiers and is cited “to be determined later” because the scope of past geotechnical investigation was limited. Additional*

pre-design investigations may be necessary to assess the feasibility of certain best management practices such as sheet pile walls with sealed joints. As discussed in the Proposed Plan of Action, EPA and USACE indicated that a potential small release of the waste material may occur during removal activities under alternative 6N. Comments received during the Proposed Plan comment period requested that EPA consider the use of additional Best Management Practices (BMPs) to prevent or minimize the release of waste material during removal. To this end, the EPA worked with USACE to further evaluate the use of BMPs to minimize releases during remedial action. One of the BMPs proposed was the use of a cofferdam with excavation in the “dry” to prevent the re-suspension and residuals that typically result from under water dredging. It should be noted that the actual BMPs to be utilized will be determined during the Remedial Design phase after engineering assessment and evaluation. All final BMPs used as part of the remedial action will have to comply with ARARs, including the requirement that there be no discharges that exceed the Texas Surface Water Quality Standards.

A cofferdam is considered to be an effective best management practice to control releases and residuals, both short- and long-term impacts, for complete removal of the waste sludge and contaminated sediments at the San Jacinto River waste pits. Cofferdams offer flexibility in construction methods and material to accommodate the local site conditions and project goals. Additionally, a cofferdam could be placed outside of the armored cap to prevent disturbance of the contaminated sediment prior to containment. Cofferdams have been constructed and dewatered in similar locales for excavation and construction activities such as at Formosa Plastics, Texas site for contaminated sediment removal, at Matagorda Bay for archeological recovery and at numerous coastal sites for flood gate, bridge and tunnel construction. Armor stone and geotextile removal are common in shoreline and coastal construction projects. Access, staging, off-site transport and off-site disposal are common to sediment removal projects and capping projects. Water treatment has also been used at many sediment removal sites such as Fox River, Ashtabula River, Onondaga Lake and Grasse River where hydraulic dredging has been employed. Construction activities on saturated sediments is also common and techniques for working on soils with low ground strength are available such as use of swamp mats, marsh excavators, marsh cargo buggies, slide pontoons and other amphibious equipment. Similar equipment and techniques were used to place the armored cap at the San Jacinto River waste pits. Removal in the “dry” eliminates the potential for resuspension and release of contaminants and contaminated water. All impacted water would be pumped from the site and treated before being discharged. It also prevents the formation of residuals from sedimentation and allows removal to the cleanup level by preventing the fluidization and spreading of the sediment in an uncontrolled manner. Additionally, removal in the “dry” facilitates the sampling, monitoring and testing of the site to ensure compliance and prevent long-term impacts from residuals.

2.5.145 Comment: Excavation of this waste will initially be accomplished by bulldozers and dry land excavators, but as the removal gets deeper, the removal will likely need amphibious vessels that can work in the muck and mud. As the waste material is removed from the deeper depths, the ability to effectively dewater the site becomes more difficult. In order to continue operations, the equipment will need the capability to work in both flooded and semi-dry conditions. This is a real complicating factor, resulting in extra time and cost working in and attempting to remove the muck (i.e. the saturated waste materials), and will result in serious construction issues including impacts on the schedule. While amphibious equipment provides the ability to operate under more

adverse conditions, it is less productive. This very time intensive work will result in the disturbed waste being exposed for long periods of time even if the armor cap and geotextile are removed in sections.

Response: *The majority of the waste is expected to be soft and saturated. Construction activities on saturated sediments is common and techniques for working on soils with low ground strength are available such as use of swamp mats, marsh excavators, marsh cargo buggies, slide pontoons and other amphibious equipment. Similar equipment and techniques were used to place the armored cap at the San Jacinto River waste pits. Excavation is not likely to be the limiting process, but multiple excavators could be used if needed. Instead, transportation, decontamination, and the rate that the landfill is able to accept wastes are likely to be the controlling factors for construction time. The armored cap above a small section of the site would be removed first and then entire depth of waste material and contaminated sediment in that small section would be removed next. The excavation would then proceed in an adjacent section using the same approach. The size of the section would be dependent on the reach of the equipment and the slumping of the waste materials. Swamp mats can improve equipment mobility and increase efficiency. A sump would be excavated along the edge below the depth of contamination to collect runoff, seepage and drainage, and improve dewatering. The sump would be pumped down as needed to maintain a dewatered site.*

2.5.146 Comment: What would happen if a hurricane or flood occurred during construction activities? I would like to know more about how you're going to contain it when a hurricane comes through.

Response: *As discussed in the Proposed Plan of Action, EPA and USACE indicated that a potential small release of the waste material may occur during removal activities under alternative 6N. Comments received during the Proposed Plan comment period requested that EPA consider the use of additional Best Management Practices (BMPs) to prevent or minimize the release of waste material during removal. To this end, the EPA worked with USACE to further evaluate the use of BMPs to minimize releases during remedial action. One of the BMPs proposed was the use of a cofferdam with excavation in the "dry" to prevent the re-suspension and residuals that typically result from under water dredging. It should be noted that the actual BMPs to be utilized will be determined during the Remedial Design phase after engineering assessment and evaluation. All final BMPs used as part of the remedial action will have to comply with ARARs, including the requirement that there be no discharges that exceed the Texas Surface Water Quality Standards.*

The site will remain covered with the armored cap until a BMP such as a cofferdam encircling the site is completed, maintaining the current level of protection at the site. The height of the cofferdam is a design decision that will require further evaluation. The proposed elevation of 10 feet NAVD 88 was based on modeled elevations presented in the Feasibility Study for a design flood with a 25- to 50-year return period. Actual flood elevations at the northern San Jacinto waste pits are uncertain and require more study. For cost estimation purposes, the top elevation of the cofferdam was 14 ft NAVD89 to prevent inundation by a 100-year or smaller flood, with a flood stage at the Site for a 100-year flood at approximately 12 ft NAVD89. The intent of the proposed cofferdam elevation is to reduce the probability and frequency of

inundation, limit the scour potential if inundated, reduce the potential volume of water to be treated from multiple dewatering events at the site, and restrict the size of delays in production. The armored cap would be incrementally removed as the waste material and contaminated sediment are excavated to depth. As such, only a small sloped face of contaminated material would be exposed at any time, limiting the potential contaminant releases. Removal operations would be stopped during hurricanes and flooding and would not resume until flooding has receded and the site has been dewatered. If the site is inundated by flooding, whether associated with a hurricane or not, the height of the proposed cofferdam and the short fetch length within the cofferdam would reduce flows and waves across the site and consequently the resulting bottom shear stress. The resulting shear stress would be too small to erode the remaining armored cap or residuals from the depths post-dredging.

2.5.147 Comment: Transport of 13,300 to 17,500 truckloads of dioxin/furans wastes through crowded neighborhoods and a highly populated county (Harris County) on the way to the disposal site (undetermined at this point) will result in transportation safety issues and environmental threats.

Response: *Concerns regarding transportation of contaminated sediment are common for all Superfund sediment removal projects. Access to I-10 is only about 1½ miles from the site via the East Freeway Service Road, which is primarily used for non-residential, commercial/industrial traffic and trucking. The removal operation would fill one truck every 10 to 15 minutes and the total traffic at the operation would be about one vehicle every six minutes, including worker traffic and deliveries. There is little other traffic over most of the route to I-10. The traffic volume is inconsequential for I-10 and its ramps, representing about 0.2 percent of the average daily truck traffic on I-10 and less than 3 percent of the ramp capacity. Therefore, the operation would not be expected to result in transportation safety issues, but further evaluations of transportation issues will be performed during the Remedial Design. Potential spills of the wastes and contaminated sediments do not pose substantial short-term human health and environmental risk. The materials are not considered hazardous under RCRA and DOT regulations since the materials are not ignitable/flammable, corrosive, reactive or toxic as characteristic of hazardous materials. Risks develop from the long-term dermal exposure or ingestion of the contaminants. The Remedial Design will develop contingency plans to prevent long-term exposure and decontaminate any spills, including those resulting from vehicle accidents. The wastes would be contained in sealed and covered trucks and the trucks will be decontaminated before leaving the site to control releases of contaminants. The primary risks from the contaminated sediments are associated with the exposure in the aquatic environment where the contaminant is able to bioaccumulate in the tissues of aquatic organisms consumed by humans and predators.*

2.5.148 Comment: Ensuring proper safeguards are in place and removal with best engineering practices is no doubt feasible. In fact, it has been completed successfully at other sites to date. With proper planning and third party oversight of the removal operation it can be a success.

Response: *Removal of contaminated sediment has been performed at more than 100 sites; ITRC (2014) presents information on more than 50 removal sites. Comparable excavation within a cofferdam was performed at the Formosa Plastics site in Texas, DuPont Gill Creek*

(SH1) site in New York. Removal in the “dry” was performed to control organic chemical liquid releases in the upper 1½ miles of the Housatonic River site using cofferdams and by-passing the river flows through large culverts. Sheet pile wall cofferdams have been used in a large sediment removal in the “dry” project in the Grand Calumet River in Indiana to control NAPL releases. The Phase I Removal Action in Passaic River included sheet pile enclosure as a cofferdam for dioxin contaminated sediment. Berms have been employed to form cofferdams to control resuspension at Hooker Chemical site in New York. Consequently, employing a double-walled cofferdam surrounding the site as the principal best management practice is expected to perform successfully.

2.5.149 Comment: To build a coffer dam around the site and dig it out is safest way to handle this situation. This can be done with best engineering practices without spreading anymore of the toxins than already have been.

***Response:** As discussed in the Proposed Plan of Action, EPA and USACE indicated that a potential small release of the waste material may occur during removal activities under alternative 6N. Comments received during the Proposed Plan comment period requested that EPA consider the use of additional Best Management Practices (BMPs) to prevent or minimize the release of waste material during removal. To this end, the EPA worked with USACE to further evaluate the use of BMPs to minimize releases during remedial action. One of the BMPs proposed was the use of a cofferdam with excavation in the “dry” to prevent the re-suspension and residuals that typically result from under water dredging. It should be noted that the actual BMPs to be utilized will be determined during the Remedial Design phase after engineering assessment and evaluation. All final BMPs used as part of the remedial action will have to comply with ARARs, including the requirement that there be no discharges that exceed the Texas Surface Water Quality Standards.*

2.5.150 Comment: What is the impact of safety and personal protection gear on project efficiency and schedules? This was not addressed in EPA's timeline.

***Response:** No significant impact on project efficiency and schedules are anticipated due to safety and personal protection gear. The construction time estimates incorporate the use of routine safety and personal protection equipment typically employed at Superfund sites. No unusual safety gear such as supplied air respirators is needed for the project.*

2.5.151 Comment: The Proposed Plan minimizes the implementability challenges associated with removal, for example – dewatering, incremental excavation, removal of the existing cap, access, off-site transport and off-site facility, and construction duration. There are significant unknowns posed by the prospect of removing an armored cap with contaminated media below it – something that has never before been performed at any site. In addition, although the Proposed Plan indicates that much of the work can be performed under “dry” conditions, the dewatering that will be required to obtain such “dry” conditions presents significant implementability issues, including the siting and construction of dewatering facilities in a manner that prevents the release of contaminants. Moreover, the wastewater that is generated by dewatering must be treated. The Proposed Plan fails to take into account these obstacles to implementation.

Response: EPA and US Army Corps of Engineers are aware of these challenges and the Proposed Plan did not seek to minimize the components of excavation in the “dry”. These components are not addressed in the plan because these details will be addressed during the Remedial Design. Despite the challenges, these remediation components have been implemented in many construction and sediment remediation projects. Cofferdams have been constructed and dewatered in similar locales for excavation and construction activities such as at Formosa Plastics, Texas site for contaminated sediment removal, at Matagorda Bay for archeological recovery and at numerous coastal sites for gate, bridge and tunnel construction. Armor stone and geotextile removal are common in shoreline and coastal construction projects. Access, staging, off-site transport and off-site disposal are common to sediment removal projects and capping projects. Water treatment has also been used at many sediment removal sites such as Fox River, Ashtabula River, Onondaga Lake and Grasse River where hydraulic dredging has been employed. EPA recognizes the concerns regarding the treatment and disposal of site generated water. The pre-design investigations will support development of applicable requirements that will be reviewed for CWA 401 water quality certification. Construction activities on saturated sediments is also commonplace and techniques for working on soils with low ground strength are available such as use of swamp mats, marsh excavators, marsh cargo buggies, slide pontoons and other amphibious equipment. Similar equipment and techniques were used to place the armored cap at the San Jacinto River waste pits.

2.6 San Jacinto River Characteristics

EPA received numerous comments from individuals in the surrounding communities, industry, industry associations, and non-governmental organizations regarding the impacts of the San Jacinto River itself on performance of a remedial action.

2.6.1 Comment: Although the riverine environment at the San Jacinto River Waste Pits is traditionally a depositional environment, the River has shown its immense force by cutting new channels and eroding large areas of material around the Pits. Most recently, the PRPs repaired a scoured area that was 60 ft. long and 8 ft. deep along the eastern side of the TCRA.

Response: *The most substantial and dramatic changes to river or estuarine environments occur as a result of extreme events, the effects of which are difficult to predict. The San Jacinto River has experienced actual short-term changes in the past. For example, the October 1994 flood, reported by the National Transportation Safety Board, resulted in "major soil erosion in the flood plain and river channel, including the creation of water channels outside the San Jacinto River bed. The flood waters scoured the riverbed and banks, destabilized roads and bridges, and inundated area homes." (NTSB, 1996). The railroad and highway roadbeds and bridges sustained major damage during the 1994 flood (USGS, 1995). More recently, the river bed scour that was identified in 2016 adjacent to the temporary cap also points to the potential for change and the dynamic nature of the river. A tidal river is an inherently more dynamic environment than would be a more stable inland location not subject to currents, changes in stage, and the more focused effects due to flooding, storm surges, and hurricanes to which the current location is subject. The San Jacinto River has been prone to severe flooding with major floods occurring in 1907, 1929, 1932, 1935, 1940, 1941, 1942, 1943, 1945, 1946, 1949, 1950, 1959, 1960, 1961, 1972, and 1978 (NTSB, 1996). The actual history of the San Jacinto River is sufficient to raise concerns about the stability of structures constructed in the river over the long time frame that the dioxin waste would remain hazardous.*

2.6.2 Comment: Flooding via storm surge is the major threat to the waste pit site and surrounding properties. The position of the site close to the mouth of a river or freshwater inflow makes it especially vulnerable given the mechanics of a storm surge. There are actually two inundation events: first, the initial rise and pulse of water inundating the waste pit site; second, the backwash of water as the surge releases back into Galveston Bay and ultimately the Gulf of Mexico. The intense tidal flushing can essentially deliver a "double dose" of pollutants to upstream residents, as well as a single downstream dose as the water returns to the Bay. Based on the NOAA hurricane surge inundation zones, the waste pit site would be inundated by any hurricane and tropical storm due to its low elevation and vulnerable location. Given its vulnerability, the site will almost certainly experience repetitive erosive surge events in the coming years, further degrading the structural integrity of on-site protective devices.

Response: *EPA agrees with this comment. The low lying waste pits at the Site are subject to flooding from storm surges generated by both tropical storms (i.e., hurricanes) and other storms. Storm surges generated in the Gulf of Mexico propagate into Galveston Bay and into the Lower San Jacinto River. Storm surge modeling conducted by the National Oceanic and Atmospheric Administration (NOAA) predicted that category 3 and 5 hurricanes that hit*

Galveston Bay during high tide would produce surge levels of 23-feet and 33-feet, respectively, at the Site (Hayter and others, 2016). The San Jacinto River Waste Pits site is located in a Federal Emergency Management Agency (FEMA) designated “VE” Floodway Zone, meaning that it is prone to inundation by the 1 percent annual chance flood event with additional hazards due to storm induced waves (Brody and others, 2014). Finally, climate models (Knutson and others, 2010) predict an increase in the intensity of tropical cyclones and hurricanes in the Gulf, meaning greater risk of flooding and storm surges over the long time frame that the dioxin waste would remain hazardous.

2.6.3 Comment: The term “upstream” is often used in the supporting documents to describe water or sediment quality (contaminant) data. Professionals and lay readers may misinterpret this term to mean quality unaffected by the Site; however, that is not the case in a tidal estuary, such as the San Jacinto River. Tidal circulation and dispersion cause Site contaminants to move predominantly downstream, but they may also move upstream. EPA should explain this imitation of the term “upstream.”

Response: *For the purpose of the study area, the term “upstream” is identified as “the river area in the opposite direction of the predominant river flow direction” and as identified visually on Figure 10 of the Proposed Plan. The actual river flow may reverse directions at times depending on the water volume being released from the dam, tidal effects, and storm surges. Sampling results in the vicinity of the Site are used to define the extent of contamination around the Site, both upstream and downstream, and not a designation of whether an area is upstream or downstream.*

2.6.4 Comment: Clarify the differences between a 100-year storm and a 100-year flood in the Proposed Plan and Feasibility Study. It would be helpful to identify that the “100-year” flood levels may change due to land subsidence, future changes in storm frequencies or intensities, or climate change.

Response: *A 100-year storm is a storm that, on average, has a 1% chance of occurring in any given year, or approximately once every 100 years. A 100-year flood is a flood that has a 1% probability of occurring in any given year. A 100-year storm does not necessarily result in a 100-year flood because there are several independent factors that can influence the relation between rainfall and river flow. These factors include the extent of rainfall in a watershed, the soil saturation before the storm, and the relation between the size of the watershed and the duration of the storm. Because the 100-year flood level is statistically computed using past data, as more data comes in, or when a river basin is altered in a way that affects the flow of water in the river, the level of the 100-year flood may change. Dams and urban development are examples of some man-made changes in a basin that affect floods. Clarification of the definition of a 100-year flood will be included in the Record of Decision.*

2.6.5 Comment: Why are the barges allowed to park on the north side of the I-10 bridge near the site with the potential to strike the cap and who approved this?

Response: *EPA has no control over the positioning of the barges.*

2.6.6 Comment: The Proposed Plan relies heavily on the possibility that the river may change course and in so doing, will destabilize the existing or enhanced cap. This possibility was based in part on historical river aerial photos during different stage/tidal conditions but not based on a full geomorphic evaluation of the river.

Response: *The USGS performed a review of the geomorphic characteristics of the San Jacinto River based on review of historic documents. Hayter and others (2016) refer to “the dynamic nature of the flow regime in the SJR [San Jacinto River] estuary” in their assessment of the hydrology and hydrodynamics of the river, referencing the location of the Waste Pits within the FEMA designated 100-year floodplain, susceptibility to flooding from storm surges, and vulnerability of the Site due to sea level rise. While it is possible to evaluate a river as dynamic in terms of its tendency towards lateral channel migration and channel avulsion, a “dynamic system” could be considered a system subject to a wide range of flooding and storm surges, and this type of activity will continue irrespective of the additional impacts of subsidence or dredging that might occur in the area. The frequency of hurricanes along any 50-mile segment of the Texas coast is about 1 every 6 years; the annual average occurrence of a tropical storm or hurricane is about 1 per year (Roth, 1997). Hurricane Ike, which made landfall near the north end of Galveston Island as a Category 2 hurricane (wind speeds of 96-110 miles per hour) caused storm surges of 15-20 feet above normal tide levels in much of the Galveston Bay area (National Hurricane Center, 2017). Warner and Tissot (2012) conservatively estimate a sea level rise at Galveston Bay of 2.1 feet over the 21st Century, and continuously increasing risks of flooding from storm surges as the century progresses. By this definition, the river could be considered dynamic, and becoming increasingly more so over time.*

It may be true that the fluvial channel of the San Jacinto River in the area of the impoundments is relatively stable. However, a tidal river is an inherently more dynamic environment than would be a more stable inland location not subject to currents, changes in stage, and the more focused effects due to flooding, storm surges, and hurricanes to which the current location of the Waste Pits is subject. An analysis of San Jacinto River channel stability based on system history does not consider projected changing conditions, such as sea level rise, that could affect system stationarity and therefore stability.

While the argument can be made that the upstream channel changes due to the 1994 flood specific to the Banana Bend area did not occur downstream at the Site because channel conditions are different, this is not to say that there were no changes in size and flow paths of the river at the Site during the flood. Net erosion of 10-12 ft in the river bed downstream of the I-10 bridge (NTBS, 1996) suggests the erosive power of flow at the bridge and in the vicinity of the impoundments was significant. Simulation of the 1994 flood by Hayter and others (2016) using the hydrodynamic module in LTFATE predicted a maximum of 6.0 ft of scour in the reach of the San Jacinto River around and a short distance downstream of the substructure of the two I-10 bridges.

Despite being designed to withstand a 100-year flood, and in the absence of floods of this magnitude since the cap was in place, portions of the current armor cap have needed repair on an annual basis. Current models are not designed to simulate the potential combination of downstream dam releases due to flooding, onshore storm surges and flooding due to hurricanes,

decreased ground stability due to saturated conditions, and the increased occurrence of higher intensity storms, making the evaluation of erosion risk in the area of the impoundments problematic. The actual history of the San Jacinto River is sufficient to raise concerns about the stability of structures constructed in the river.

2.6.7 Comment: The Proposed Plan should include evaluation of potential river changes that could occur and how quickly those changes could occur. That evaluation should then be the basis for development of an operations and maintenance plan. Rivers usually change over hundreds of years, which is why there is operation and maintenance.

Response: *The most substantial and dramatic changes to river or estuarine environments occur as a result of extreme events, the effects of which are more difficult to predict. The San Jacinto River has experienced actual short-term changes in the past. For example, the 1994 flood, reported by the National Transportation Safety Board, resulted in new channels eroding in the floodplain and undermining of pipelines in the area. Further, the river bed scour that was identified in 2016 adjacent to the temporary cap also points to the potential for change and the dynamic nature of the river. A tidal river is an inherently more dynamic environment than would be a more stable inland location not subject to currents, changes in stage, and the more focused effects due to flooding, storm surges, and hurricanes to which the current location is subject. The actual history of the San Jacinto River is sufficient to raise concerns about the stability of structures constructed in the river.*

A long term maintenance program would generally have the most application for a containment remedy, which would need to secure the impoundments for a long time. The ground water and the surface water would require regular sampling and review to confirm that there are no future releases, in addition to the regular containment structure inspections to confirm its continued integrity. Climate models (Knutson and others, 2010) predict an increase in the intensity of tropical cyclones and hurricanes in the Gulf, meaning greater risk of flooding and storm surges. Predicting long-term future conditions on which to base a maintenance plan would be uncertain.

2.6.8 Comment: A full geomorphic evaluation should be completed to assess the potential for the configuration of the river to change abruptly.

Response: *The USGS performed a review of the geomorphic characteristics of the San Jacinto River based on review of historic documents. However, geomorphic evaluations based on the behavior of upland river systems may not accurately simulate scenarios in a river downstream of a reservoir and in immediate contact with a tidal estuary. Also, what cannot be accurately predicted are the conditions that the impoundments and channels will be subjected to, given the need to secure the impoundments for the long time that the dioxin would remain hazardous. The San Jacinto River has experienced actual short-term changes in the past. For example, the 1994 flood, reported by the National Transportation Safety Board, resulted in new channels eroding in the floodplain and undermining of pipelines in the area. In addition, the river bed scour that was identified in 2016 adjacent to the temporary cap also points to the potential for change and the dynamic nature of the river. A tidal river is an inherently more dynamic environment than would be a more stable inland location not subject to currents,*

changes in stage, and the more focused effects due to flooding, storm surges, and hurricanes to which the current location is subject.

2.6.9 Comment: What is the chance of the cap failing vs geomorphic change occurring? Performing a geomorphology analysis to evaluate the potential for abrupt changes in the river channel that might impact the Alternative 3aN cap and to determine whether engineering solutions exist for those potential impacts.

Response: *The USGS performed a review of the geomorphic characteristics of the San Jacinto River based on review of historic documents. A variety of models could be used to test potential effects to specific areas of the stream channel or impoundments with the application of specific stress conditions. However, the complex way in which the effects of these individual stresses interact and propagate through the river system in the area of the impoundments cannot be reliably simulated with existing models. The San Jacinto River has experienced actual abrupt changes in the past. For example, the 1994 flood, reported by the National Transportation Safety Board, resulted in new channels eroding in the floodplain and undermining of pipelines in the area. In addition, the river bed scour that was identified in 2016 adjacent to the temporary cap also points to the potential for change and the dynamic nature of the river. A tidal river is an inherently more dynamic environment than would be a more stable inland location not subject to currents, changes in stage, and the more focused effects due to flooding, storm surges, and hurricanes to which the current location is subject.*

2.6.10 Comment: Region 6 explicitly bases its rejection of Alternative 3aN on the possibility of a future abrupt change in the San Jacinto River's channel as a factor that could potentially cause the Alternative 3aN cap to fail. Region 6 did not, however, conduct a formal geomorphic evaluation of the river. In fact, the Administrative Record does not contain any credible support for concluding that the river could change course in the manner it speculates could occur.

Response: *The USGS performed a review of the geomorphic characteristics of the San Jacinto River based on review of historic documents. However, geomorphic evaluations based on the behavior of upland river systems may not accurately simulate scenarios in a river downstream of a reservoir and in immediate contact with a tidal estuary. Also, what cannot be accurately predicted are the conditions that the impoundments and channels will be subjected to, given the need to secure the impoundments for the long time that the dioxin would remain hazardous. The San Jacinto River has experienced actual short-term changes in the past. For example, the 1994 flood, reported by the National Transportation Safety Board, resulted in new channels eroding in the floodplain and undermining of pipelines in the area. In addition, the river bed scour that was identified in 2016 adjacent to the temporary cap also points to the potential for change and the dynamic nature of the river. A tidal river is an inherently more dynamic environment than would be a more stable inland location not subject to currents, changes in stage, and the more focused effects due to flooding, storm surges, and hurricanes to which the current location is subject. Finally, climate models (Knutson and others, 2010) predict an increase in the intensity of tropical cyclones and hurricanes in the Gulf, meaning greater risk of flooding and storm surges over the long time frame that the dioxin waste would remain hazardous.*

The Corps of Engineers performed a more recent model simulation to investigate the performance of the upgraded cap, Alternative 3aN. The results of the Alternative 3aN modeling showed that erosion of the cap would likely occur over most of the cap during the extreme storm event modeled. This modeling considered the wave impacts from a Category 2 hurricane (Hurricane Ike). However, even stronger hurricanes capable of achieving Category 3, 4, or 5 levels are possible during the long term that the dioxin would remain toxic. The removal of the waste material will provide a long-term solution to protect the community, eliminate the potential for a release to the environment, and prevent the Site from becoming a large contaminated sediment site.

2.6.11 Comment: Region 6's stated rationale for not undertaking such an evaluation is that modeling has limited applicability to geomorphic changes. Whatever the perceived limitations of modeling as a tool to evaluate such an event may be, that does not excuse Region 6 from performing a technical evaluation to support this claim. That is particularly true because Region 6 points to this argument as one of its primary reasons for rejecting capping as a protective remedy.

Response: *The USGS performed a review of the geomorphic characteristics of the San Jacinto River based on review of historic documents. A variety of models could be used to test potential effects to specific areas of the stream channel or impoundments with the application of specific stress conditions. However, the complex way in which the effects of these individual stresses interact and propagate through the river system in the area of the impoundments cannot be simulated with existing models. The San Jacinto River has experienced actual abrupt changes in the past. For example, the 1994 flood, reported by the National Transportation Safety Board, resulted in new channels eroding in the floodplain and undermining of pipelines in the area. In addition, the river bed scour that was identified in 2016 adjacent to the temporary cap also points to the potential for change and the dynamic nature of the river. The actual history of the San Jacinto River is sufficient to raise concerns about the stability of structures constructed in the river. A tidal river is an inherently more dynamic environment than would be a more stable inland location not subject to currents, changes in stage, and the more focused effects due to flooding, storm surges, and hurricanes to which the current location is subject. Finally, climate models (Knutson and others, 2010) predict an increase in the intensity of tropical cyclones and hurricanes in the Gulf, meaning greater risk of flooding and storm surges over the long time period that the dioxin waste would remain hazardous.*

2.6.12 Comment: With regard to Region 6's assertions about abrupt river channel migration: There is no support for Region 6's assertion that the river channel has "changed over time," based on a limited set of aerial photographs from 1956, 1966, 1973, and 1997. These photographs visually show inundated areas but not "channel migration" and do not support Region 6's assertion that they "clearly show that the river channel has changed over time." In fact, although the river is a dynamic system, which is subject to changes in size and flow paths, the main channel of the river is very stable.

Response: *A tidal river, as exists at the Site, is an inherently more dynamic environment than would be a more stable inland location not subject to currents, changes in stage, and the more focused effects due to flooding, storm surges, and hurricanes to which the current location*

is subject. Analysis of channel stability based on system history does not consider projected changing conditions, such as sea level rise, that could affect system stationarity and therefore stability. The San Jacinto River has experienced actual abrupt changes in the past. For example, the 1994 flood, reported by the National Transportation Safety Board (NTSB, 1996), resulted in new channels eroding in the floodplain and undermining of pipelines in the area. In addition, the river bed scour that was identified in 2016 adjacent to the temporary cap also points to the potential for change and the dynamic nature of the Site location. The actual history of the San Jacinto River is sufficient to raise concerns about the stability of structures constructed in the river. Finally, climate models (Knutson and others, 2010) predict an increase in the intensity of tropical cyclones and hurricanes in the Gulf, meaning greater risk of flooding and storm surges over the long time period that the dioxin waste would remain hazardous.

To provide more detail to the response, the NTSB (1996) report refers to sonar tests performed around the substructure of critical sections of the I-10 bridge, but there was no specific reference in the NTSB (1996) report to tests over the entire area of the Northern Impoundment, or reference as to whether the impoundments were eroded. Despite a search of available literature, no additional references were found giving more detail about where the sonar tests referred to in the NTSB (1996) report were located. Thus the statement that “The Northern and Southern Impoundments were not scoured during the 1994 flood, despite the 10-12 ft of scour in the main channel downstream from the bridge and the fact that the Northern Impoundments were not capped at the time” cannot be evaluated. Classification schemes such as those by Lagasse and others (2004), used to establish channel stability, were designed to classify upland river systems. The San Jacinto River in this reach is downstream of a dam and is part of a coastal plain estuary. As such, there are additional forces acting on the river, such as downriver releases from the dam and upriver/onshore forces such as hurricanes and storm surges, which can affect the morphology of the area in ways not accounted for in an upland river classification scheme. A 2 ft rise in sea level (Warner and Tissot, 2012) and an increase in the frequency of high intensity hurricanes due to a rise in sea surface temperatures (Knutson and others, 2010), are among the changes predicted in the 21st Century that would affect the San Jacinto River in the area of the impoundments.

2.6.13 Comment: Region 6 has apparently made no effect to disaggregate the effects of subsidence, erosion and dredging on channel morphology.

Response: *The United States Army Corps of Engineers reported that changes in channel planform morphology due to bank erosion and shoreline breaches, etc., is beyond the ability of existing sediment transport models to simulate. However, the Corps’ modeling did account for changes in morphology due to erosion and deposition. EPA is aware of the subsidence, erosion, and dredging that has occurred in the vicinity of the site. The erosion, as occurred during the 1994 flood and in 2016 adjacent to the temporary cap, for example, is one of the contributing factors raising uncertainties about the long term integrity of a structure meant to contain dioxin waste in the San Jacinto River. Regarding dredging, or sand mining, the National Transportation Safety Board in their report on the 1994 flood linked the erosion that occurred in the Banana Bend area with sand mining. EPA notes that sand mining also occurred immediately upstream and adjacent to the waste pits.*

A region of major subsidence is centered on the Site. Historical subsidence of up to 10 ft between 1906 and 1979 in the vicinity of the Site has been reported by the Harris Galveston Subsidence District, Bawden et al. (2012), and others. Subsidence has been arrested by institutional controls on groundwater extraction that are in place at the regional scale. The Corps of Engineers reported that the impact of any continued subsidence would be dependent on the rate of subsidence, which is not well known and cannot be predicted with any reliability. However, subsidence, and the slow rise of sea level, would both result in slightly deeper water depths in the area, but it is not believed that these effects would be substantial enough to affect the tidal, river, and wind induced circulation in the San Jacinto River estuary (Hayter and others, 2016).

2.6.14 Comment: While Region 6 asserts that the San Jacinto River is a very dynamic system, subject to changes in size and flow paths as experienced during the 1994 storm, in fact: examination of rectified aerial photos and maps show that the 1994 storm did not change the location or alignment of the main channel of the river within 2 miles of the Northern Impoundments.

Response: *While the argument can be made that the upstream channel changes due to the 1994 flood specific to the Banana Bend area did not occur downstream at the Site because channel conditions are different, this is not to say that there were no changes in size and flow paths of the river at the Site during the flood. Net erosion of 10-12 ft in the river bed downstream of the I-10 Bridge (NTBS, 1996) suggests the erosive power of flow at the bridge and in the vicinity of the impoundments was significant. Simulation of the 1994 flood by Hayter and others using the hydrodynamic module in LTFATE predicted a maximum of 6.0 ft of scour in the reach of the San Jacinto River around and a short distance downstream of the substructure of the I-10 bridge. More recently, in 2016, about 8-feet of riverbed scour occurred immediately adjacent to the temporary cap. While this scour area was repaired by covering it with armor rock, there is little certainty that a high intensity flood or a severe hurricane would not have resulted in significantly increased scour or damage to the temporary cap.*

Hayter and others (2016) refer to “the dynamic nature of the flow regime in the SJR estuary” in their assessment of the hydrology and hydrodynamics of the river, referencing the location of the Waste Pits within the FEMA designated 100-year floodplain, susceptibility to flooding from storm surges, and vulnerability of the Site due to sea level rise. A “dynamic system” could be considered a system subject to a wide range of flooding and storm surges, and this type of activity will continue irrespective of the additional impacts of subsidence or dredging. The frequency of hurricanes along any 50-mile segment of the Texas coast is about 1 every 6 years; the annual average occurrence of a tropical storm or hurricane is about 1 per year (Roth, 1997). Hurricane Ike, which made landfall near the north end of Galveston Island as a Category 2 hurricane (wind speeds of 96-110 miles per hour) caused storm surges of 15-20 feet above normal tide levels in much of the Galveston Bay area (National Hurricane Center, 2017). Warner and Tissot (2012) conservatively estimate a sea level rise at Galveston Bay of 2.1 feet over the 21st Century, and continuously increasing risks of flooding from storm surges as the century progresses. By this definition, the river may be considered dynamic, and becoming increasingly more so over time.

2.6.15 Comment: Changes associated with the 1994 storm consisted of erosion of high flow paths through floodplain sand mines (pits) and scour downstream from the I-10 bridge. Neither type of erosion resulting from the 1994 storm imperiled or caused erosion of the Northern Impoundments, even though there was no armored cap in place at the time; and neither type of erosion produced an avulsion [rapid abandonment of an existing river channel and creation of a new channel] in the main channel of the river. The extrapolation of rates of channel change from upstream reaches of the river (i.e., Banana Bend) to the reach immediately adjacent to the Northern Impoundments is not supported by evidence or logic.

Response: *While the argument can be made that the upstream channel changes due to the 1994 flood specific to the Banana Bend area did not occur downstream at the Site because channel conditions are different, this is not to say that there were no changes in size and flow paths of the river at the Site during the flood. Net erosion of 10-12 ft in the river bed downstream of the I-10 Bridge (NTBS, 1996) suggests the erosive power of flow at the bridge and in the vicinity of the impoundments was significant. Simulation of the 1994 flood by Hayter and others (2016) using the hydrodynamic module in LTFATE predicted a maximum of 6.0 ft of scour in the reach of the San Jacinto River around and a short distance downstream of the substructure of the I-10 bridge. More recently, in 2016, about 8-feet of riverbed scour occurred immediately adjacent to the temporary cap. While this scour area was repaired by covering it with armor rock, there is little certainty that a high intensity flood or a severe hurricane would not have resulted in significantly increased scour or damage to the temporary cap.*

2.6.16 Comment: The main channel of the river channel is stable with respect to the fluvial processes of lateral migration and avulsion and therefore cannot be characterized as “very dynamic.”

Response: *It may be true that the fluvial channel of the San Jacinto River in the area of the impoundments is relatively stable. However, a tidal river is an inherently more dynamic environment than would be a more stable inland location not subject to currents, changes in stage, and the more focused effects due to flooding, storm surges, and hurricanes to which the current location of the Waste Pits is subject. An analysis of San Jacinto River channel stability based on system history does not consider projected changing conditions, such as sea level rise, that could affect system stationarity and therefore stability. Classification schemes such as those by Lagasse and others (2004), which can be used to establish channel stability, were designed to classify upland river systems. The San Jacinto River in this reach is downstream of a dam and is part of a coastal-plain estuary. As such, there are additional forces acting on the river, such as downriver releases from the dam and upriver/onshore forces such as hurricanes and storm surges, which can affect the morphology of the area in ways not accounted for in an upland river classification scheme. A 2 ft rise in sea level (Warner and Tissot, 2012) and an increase in the frequency of high intensity hurricanes due to a rise in sea surface temperatures (Knutson and others, 2010) are among the changes predicted in the next century that would affect the San Jacinto River in the area of the impoundments.*

While the argument can be made that the upstream channel changes due to the 1994 flood specific to the Banana Bend area did not occur downstream at the Site because channel conditions are different, this is not to say that there were no changes in size and flow paths of the

river at the Site during the flood. Net erosion of 10-12 ft in the river bed downstream of the I-10 bridge (NTBS, 1996) suggests the erosive power of flow at the bridge and in the vicinity of the impoundments was significant. Simulation of the 1994 flood by Hayter and others (2016) using the hydrodynamic module in LTFATE predicted a maximum of 6.0 ft of scour in the reach of the San Jacinto River around and a short distance downstream of the substructure of the two I-10 bridges.

Sea level rise in the Galveston area is conservatively projected to be 2.1 feet over the 21st Century (Warner and Tissot, 2012), which will cause storm surge floods to progress further inland, and increase the frequency and intensity of flooding in the area of the impoundments. Despite being designed to withstand a 100-year flood, and in the absence of floods of this magnitude since the cap was in place, portions of the current armor cap have needed repair on an annual basis. Current models are not designed to simulate the potential combination of downstream dam releases due to flooding, onshore storm surges and flooding due to hurricanes, decreased ground stability due to saturated conditions, and the increased occurrence of higher intensity storms, making the evaluation of erosion risk in the area of the impoundments problematic.

Hayter and others (2016) refer to “the dynamic nature of the flow regime in the SJR estuary” in their assessment of the hydrology and hydrodynamics of the river, referencing the location of the Waste Pits within the FEMA designated 100-year floodplain, susceptibility to flooding from storm surges, and vulnerability of the Site due to sea level rise. A “dynamic system” could be considered a system subject to a wide range of flooding and storm surges, and this type of activity will continue irrespective of the additional impacts of subsidence or dredging.

2.6.17 Comment: Past “changes” in the river identified by Region 6 were highly influenced by conditions that no longer exist (e.g., subsidence and dredging), so there is no credible basis for Region 6’s assertion that such “changes” will continue into the future.

Response: Changes in the river are influenced by the location of the Waste Pits within the FEMA designated 100-year floodplain, susceptibility to flooding from storm surges, and vulnerability of the Site due to sea level rise. The system is subject to a wide range of flooding and storm surges, and this type of activity will continue irrespective of the additional impacts of subsidence or dredging.

2.6.18 Comment: Future storm events and potential climate changes will push the river towards adapting to future flows by erosion of the weakest portions of the river’s channel, the soft-fine-grained sediments and banks, rather than a highly armored structure, such as the Alternative 3aN enhanced cap.

Response: Although the soft-grained sediments may be the first area of the river to erode during an extreme event, this does not preclude these changes from also compromising the cap. For example, the evaluation and modelling performed by the Corps of Engineers (Hayter and others, 2016) showed that the cap with additional upgrades (Alternative 3N), in addition to the 2012 upgrades, was still predicted to incur extensive erosion over 80 percent of the cap during a hurricane scenario. The Corps of Engineers performed a more recent model simulation to

investigate the performance of the upgraded cap, Alternative 3aN. The results of the Alternative 3aN modeling showed that erosion of the cap would likely occur over most of the cap during the extreme storm event modeled. This modeling considered the wave impacts from a Category 2 hurricane (Hurricane Ike). However, even stronger hurricanes capable of achieving Category 3, 4, or 5 levels are possible during the long term that the dioxin would remain toxic. The removal of the waste material will provide a long-term solution to protect the community, eliminate the potential for a release to the environment, and prevent the Site from becoming a large contaminated sediment site.

2.6.19 Comment: Tools (including models) exist that could be used to evaluate the potential for the kind of event that Region 6 posits might occur. For example, there are morphodynamic models that can be used to assess meander migration and existing 2-dimensional hydrodynamic models and their output can be used to assess channel boundary erosion potential during extreme events. There are also tools that can be used to address model uncertainty. ERDC, the section of the US Army Corps of Engineers that evaluated the remedial alternatives for Region 6, has staff with specific expertise in such assessments.

***Response:** The comment is correct that a variety of models could be used to test potential effects to specific areas of the stream channel or impoundments with the application of specific stress conditions. However, the complex way in which the effects of these individual stresses interact and propagate through the river system in the area of the impoundments cannot be simulated with existing models. The models suggested as candidates (HEC RAS 5.0 with BSTEM and the morphodynamic meander models of Langendoen and others (2015 and 2016)) were designed to model upland river systems. The need to simulate scenarios in a river downstream of a reservoir and in immediate contact with a tidal estuary introduces factors into the analysis not accounted for in these models. Also, what cannot be accurately predicted are the conditions that the impoundments and channels will be subjected to, given the need to secure the impoundments for the next 500 years. The impoundments are currently located in a tidal river, in an industrial area, which is also seeing increases in population – with concurrent needs for increased infrastructure and municipal water supplies. Climate models predict an increase in the intensity of tropical cyclones and hurricanes in the Gulf, meaning greater risk of flooding and storm surges. Accurately evaluating the uncertainty of model predictions would be problematic given uncertainties in long-term future conditions.*

2.6.20 Comment: If Region 6 selects its preferred remedy largely on the basis of the possibility of future channel migration, that would suggest that every other chemical plant, manufacturing facility, or hazardous waste storage location along the San Jacinto River and Houston Ship Channel could be held to this standard as well.

***Response:** A remedy selection is not based on channel migration or any other single factor; instead the selection is based on EPA's consideration of the nine Comprehensive Environmental Response, Compensation, and Liability Act ("CERCLA") criteria, including overall protection of human health and the environment; compliance with applicable or relevant and appropriate standards; long-term effectiveness and permanence; reduction of toxicity, mobility or volume; short-term effectiveness; implementability; cost; state acceptance; and community acceptance. The statement that any decision for the site would also apply to other*

manufacturing facilities, chemical plants, etc., is purely speculative; the requirements for these other facilities would depend on the applicable law, each site's characteristics and risks, what chemicals are potential threats to the environment, etc.

2.6.21 Comment: Should Region 6 not select Alternative 3aN, it should defer selecting a remedy until a full geomorphic evaluation is completed to assess the potential for the configuration of the river to change abruptly, and to evaluate whether the Alternative 3aN cap includes or may be modified to include adequate safeguards against changes in the river channel if this is determined to be a real issue.

Response: *USGS performed a review of the geomorphic characteristics of the San Jacinto River based on review of historic document. However, the EPA does not agree that it would be appropriate to delay completing the final remedial action for the site to allow completion of additional studies. While a variety of models could be used to test potential effects to specific areas of the stream channel or impoundments with the application of specific stress conditions, the complex way in which the effects of these individual stresses interact and propagate through the river system in the area of the impoundments cannot be reliably simulated with existing models. Models designed to model upland river systems do not simulate scenarios in a river downstream of a reservoir and in immediate contact with a tidal estuary. Also, what can't be accurately predicted are the conditions that the impoundments and channels will be subjected to in the future given the need to secure the impoundments for the long term.*

Regarding the appropriateness of Alternative 3aN, the Corps of Engineers performed a more recent model simulation to investigate the performance of the upgraded cap, Alternative 3aN. The results of the Alternative 3aN modeling showed that erosion of the cap would likely occur over most of the cap during the extreme storm event modeled. This modeling considered the wave impacts from a Category 2 hurricane (Hurricane Ike). However, even stronger hurricanes capable of achieving Category 3, 4, or 5 levels are possible during the long term that the dioxin would remain toxic. The removal of the waste material will provide a long-term solution to protect the community, eliminate the potential for a release to the environment, and prevent the Site from becoming a large contaminated sediment site.

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TABLES

Table 1
Summary Statistics for Dioxin and Furan Concentrations in Surface Soil Samples from the TxDOT Right-of-Way and North of I-10

Analyte	Units	Number of Samples	Number of Detected Measurements	Detection Frequency	Detected Data		All Data
					Minimum	Maximum	Mean
Area 1							
2,3,7,8-TCDD	ng/kg	31	13	42%	0.318	6.58	1.05
1,2,3,7,8-PeCDD	ng/kg	31	10	32%	0.159	1.96	0.294
1,2,3,4,7,8-HxCDD	ng/kg	31	18	58%	0.0802	2.5	0.585
1,2,3,6,7,8-HxCDD	ng/kg	31	24	77%	0.381	16.3	2.97
1,2,3,7,8,9-HxCDD	ng/kg	31	25	81%	0.169	8.03	2.03
1,2,3,4,6,7,8-HpCDD	ng/kg	31	31	100%	0.829	1,010	117
OCDD	ng/kg	31	31	100%	17.1	35,400	3,670
2,3,7,8-TCDF	ng/kg	31	22	71%	0.506	26	5.28
1,2,3,7,8-PeCDF	ng/kg	31	9	29%	0.114	4.91	0.483
2,3,4,7,8-PeCDF	ng/kg	31	14	45%	0.248	7.68	0.828
1,2,3,4,7,8-HxCDF	ng/kg	31	28	90%	0.071	29.2	3.07
1,2,3,6,7,8-HxCDF	ng/kg	31	16	52%	0.155	11.2	1.11
1,2,3,7,8,9-HxCDF	ng/kg	31	3	10%	0.0974	0.868	0.138
2,3,4,6,7,8-HxCDF	ng/kg	31	17	55%	0.119	4.42	0.834
1,2,3,4,6,7,8-HpCDF	ng/kg	31	29	94%	0.0805	103	16.2
1,2,3,4,7,8,9-HpCDF	ng/kg	31	19	61%	0.18	19.8	1.89
OCDF	ng/kg	31	30	97%	0.93	700	94.4
TEQ _{DF,M}	ng/kg	31	31	100%	0.456	27.2	5.7
Area 2							
2,3,7,8-TCDD	ng/kg	12	8	67%	0.434	46.5	6.39
1,2,3,7,8-PeCDD	ng/kg	12	7	58%	0.153	1.03	0.371
1,2,3,4,7,8-HxCDD	ng/kg	12	9	75%	0.103	1.65	0.650
1,2,3,6,7,8-HxCDD	ng/kg	12	11	92%	0.118	7.88	2.96
1,2,3,7,8,9-HxCDD	ng/kg	12	11	92%	0.221	5.47	2.12
1,2,3,4,6,7,8-HpCDD	ng/kg	12	12	100%	5.28	319	103
OCDD	ng/kg	12	12	100%	229	6,870	2,290
2,3,7,8-TCDF	ng/kg	12	10	83%	0.581	161	23.8
1,2,3,7,8-PeCDF	ng/kg	12	8	67%	0.19	5.47	0.983

Table 1
Summary Statistics for Dioxin and Furan Concentrations in Surface Soil Samples from the TxDOT Right-of-Way and North of I-10

Analyte	Units	Number of Samples	Number of Detected Measurements	Detection Frequency	Detected Data		All Data
					Minimum	Maximum	Mean
2,3,4,7,8-PeCDF	ng/kg	12	8	67%	0.264	3.73	0.875
1,2,3,4,7,8-HxCDF	ng/kg	12	10	83%	0.677	6.12	2.37
1,2,3,6,7,8-HxCDF	ng/kg	12	8	67%	0.266	1.82	0.884
1,2,3,7,8,9-HxCDF	ng/kg	12	0	0%	NA	NA	0.0595
2,3,4,6,7,8-HxCDF	ng/kg	12	10	83%	0.219	2.94	1.08
1,2,3,4,6,7,8-HpCDF	ng/kg	12	11	92%	1.87	61.1	16.7
1,2,3,4,7,8,9-HpCDF	ng/kg	12	9	75%	0.347	4.29	1.32
OCDF	ng/kg	12	11	92%	6.39	347	85.5
TEQ _{DF,M}	ng/kg	12	12	100%	0.212	66.1	12.4
Area 3							
2,3,7,8-TCDD	ng/kg	9	9	100%	0.575	8,650	2,120
1,2,3,7,8-PeCDD	ng/kg	9	7	78%	0.369	57.2	17.7
1,2,3,4,7,8-HxCDD	ng/kg	9	3	33%	0.163	0.750	0.241
1,2,3,6,7,8-HxCDD	ng/kg	9	4	44%	0.910	6.54	1.44
1,2,3,7,8,9-HxCDD	ng/kg	9	8	89%	0.151	3.34	0.961
1,2,3,4,6,7,8-HpCDD	ng/kg	9	9	100%	3.00	191	49.0
OCDD	ng/kg	9	9	100%	118	2,350	799
2,3,7,8-TCDF	ng/kg	9	9	100%	2.88	20,600	6,680
1,2,3,7,8-PeCDF	ng/kg	9	8	89%	3.6	959	313
2,3,4,7,8-PeCDF	ng/kg	9	8	89%	2.48	465	156
1,2,3,4,7,8-HxCDF	ng/kg	9	9	100%	0.207	2,110	665
1,2,3,6,7,8-HxCDF	ng/kg	9	8	89%	1.70	498	149
1,2,3,7,8,9-HxCDF	ng/kg	9	6	67%	0.359	25.5	8.43
2,3,4,6,7,8-HxCDF	ng/kg	9	7	78%	1.14	69.7	23.9
1,2,3,4,6,7,8-HpCDF	ng/kg	9	8	89%	2.11	668	189

Table 1
Summary Statistics for Dioxin and Furan Concentrations in Surface Soil Samples from the TxDOT Right-of-Way and North of I-10

Analyte	Units	Number of Samples	Number of Detected Measurements	Detection Frequency	Detected Data		All Data
					Minimum	Maximum	Mean
1,2,3,4,7,8,9-HpCDF	ng/kg	9	7	78%	2.83	244	72.9
OCDF	ng/kg	9	8	89%	3.74	363	104
TEQ _{DF,M}	ng/kg	9	9	100%	1.02	11,200	2,950

Notes

Mean calculations include detected and nondetected values. Nondetected values were set to one-half the detection limit.

Surface is defined as any sample with an upper depth of 0 feet.

NA = not applicable, no detected values

TEQ_{DF,M} (ND=1/2DL) = Toxicity equivalent for 2,3,7,8-tetrachlorinated dibenzo-p-dioxin (TCDD) calculated using dioxins and furans and mammalian toxicity equivalency factors (Van den Berg et al. 2006) with nondetects set at one-half the detection limit.

TxDOT = Texas Department of Transportation

Modified from: Integral Consulting Inc. and Anchor QEA, LLC. 2013. Remedial Investigation Report, San Jacinto River Waste Pits Superfund Site.
 Prepared for: McGinnes Industrial Maintenance Corporation, International Paper Company, and U.S. Environmental Protection Agency, Region 6. May.

Table 2
Summary Statistics for Dioxin and Furan Concentrations in Subsurface Soil Samples from the TxDOT Right-of-Way and North of I-10

Analyte	Units	Number of Samples	Number of Detected Measurements	Detection Frequency	Detected Data		All Data
					Minimum	Maximum	Mean
Area 1							
2,3,7,8-TCDD	ng/kg	39	19	49%	0.268	144	5.18
1,2,3,7,8-PeCDD	ng/kg	39	17	44%	0.139	2.58	0.331
1,2,3,4,7,8-HxCDD	ng/kg	39	21	54%	0.118	3.11	0.529
1,2,3,6,7,8-HxCDD	ng/kg	39	31	79%	0.179	18.2	2.79
1,2,3,7,8,9-HxCDD	ng/kg	39	26	67%	0.291	8.34	1.86
1,2,3,4,6,7,8-HpCDD	ng/kg	39	39	100%	1.33	1,080	114
OCDD	ng/kg	39	39	100%	32.5	30,700	4,500
2,3,7,8-TCDF	ng/kg	39	32	82%	0.306	459	18.6
1,2,3,7,8-PeCDF	ng/kg	39	17	44%	0.154	10.8	0.862
2,3,4,7,8-PeCDF	ng/kg	39	20	51%	0.264	7.44	0.853
1,2,3,4,7,8-HxCDF	ng/kg	39	29	74%	0.188	21.5	2.63
1,2,3,6,7,8-HxCDF	ng/kg	39	26	67%	0.108	8.25	1.01
1,2,3,7,8,9-HxCDF	ng/kg	39	4	10%	0.0711	0.522	0.0981
2,3,4,6,7,8-HxCDF	ng/kg	39	23	59%	0.0707	6.69	0.864
1,2,3,4,6,7,8-HpCDF	ng/kg	39	36	92%	0.118	129	13.4
1,2,3,4,7,8,9-HpCDF	ng/kg	39	21	54%	0.201	12.9	1.33
OCDF	ng/kg	39	35	90%	0.229	777	73.2
TEQ _{DF,M}	ng/kg	39	39	100%	0.357	195	11.3
Area 2							
2,3,7,8-TCDD	ng/kg	2	1	50%	0.547	0.547	0.304
1,2,3,7,8-PeCDD	ng/kg	2	1	50%	0.152	0.152	0.105
1,2,3,4,7,8-HxCDD	ng/kg	2	1	50%	0.198	0.198	0.150
1,2,3,6,7,8-HxCDD	ng/kg	2	2	100%	0.185	0.476	0.331
1,2,3,7,8,9-HxCDD	ng/kg	2	1	50%	0.387	0.387	0.279
1,2,3,4,6,7,8-HpCDD	ng/kg	2	2	100%	6.82	18.6	12.7
OCDD	ng/kg	2	2	100%	247	484	366
2,3,7,8-TCDF	ng/kg	2	1	50%	1.74	1.74	0.876

Table 2
Summary Statistics for Dioxin and Furan Concentrations in Subsurface Soil Samples from the TxDOT Right-of-Way and North of I-10

Analyte	Units	Number of Samples	Number of Detected Measurements	Detection Frequency	Detected Data		All Data
					Minimum	Maximum	Mean
1,2,3,7,8-PeCDF	ng/kg	2	0	0%	NA	NA	0.0282
2,3,4,7,8-PeCDF	ng/kg	2	0	0%	NA	NA	0.0297
1,2,3,4,7,8-HxCDF	ng/kg	2	0	0%	NA	NA	0.0307
1,2,3,6,7,8-HxCDF	ng/kg	2	0	0%	NA	NA	0.0268
1,2,3,7,8,9-HxCDF	ng/kg	2	0	0%	NA	NA	0.0271
2,3,4,6,7,8-HxCDF	ng/kg	2	0	0%	NA	NA	0.0215
1,2,3,4,6,7,8-HpCDF	ng/kg	2	0	0%	NA	NA	0.104
1,2,3,4,7,8,9-HpCDF	ng/kg	2	0	0%	NA	NA	0.0271
OCDF	ng/kg	2	1	50%	2.83	2.83	1.42
TEQ _{DF,M}	ng/kg	2	2	100%	0.441	1.22	0.831
Area 3							
2,3,7,8-TCDD	ng/kg	9	9	100%	3.32	11,300	4,560
1,2,3,7,8-PeCDD	ng/kg	9	8	89%	0.781	85.5	39.2
1,2,3,4,7,8-HxCDD	ng/kg	9	4	44%	0.657	1.15	0.504
1,2,3,6,7,8-HxCDD	ng/kg	9	7	78%	0.333	12.9	3.71
1,2,3,7,8,9-HxCDD	ng/kg	9	6	67%	0.321	3.49	1.66
1,2,3,4,6,7,8-HpCDD	ng/kg	9	9	100%	5.41	475	111
OCDD	ng/kg	9	9	100%	202	4,310	1,400
2,3,7,8-TCDF	ng/kg	9	9	100%	15.6	43,000	17,000
1,2,3,7,8-PeCDF	ng/kg	9	9	100%	0.544	1,450	642
2,3,4,7,8-PeCDF	ng/kg	9	8	89%	5.00	735	349
1,2,3,4,7,8-HxCDF	ng/kg	9	8	89%	12.6	3,060	1090
1,2,3,6,7,8-HxCDF	ng/kg	9	9	100%	0.256	691	256
1,2,3,7,8,9-HxCDF	ng/kg	9	7	78%	0.296	43.2	13.9
2,3,4,6,7,8-HxCDF	ng/kg	9	7	78%	2.71	92.7	41.6
1,2,3,4,6,7,8-HpCDF	ng/kg	9	9	100%	0.737	782	305

Table 2
Summary Statistics for Dioxin and Furan Concentrations in Subsurface Soil Samples from the TxDOT Right-of-Way and North of I-10

Analyte	Units	Number of Samples	Number of Detected Measurements	Detection Frequency	Detected Data		All Data
					Minimum	Maximum	Mean
1,2,3,4,7,8,9-HpCDF	ng/kg	9	8	89%	1.10	296	112
OCDF	ng/kg	9	9	100%	1.43	412	184
TEQ _{DF,M}	ng/kg	9	9	100%	5.21	16,200	6,560

Notes

Mean calculations include detected and nondetected values. Nondetected values were set to one-half the detection limit.

Subsurface is defined as any sample with an upper depth greater than 0 feet.

NA = not applicable, no detected values

TEQ_{DF,M} (ND=1/2DL) = Toxicity equivalent for 2,3,7,8-tetrachlorinated dibenzo-p-dioxin (TCDD) calculated

TxDOT = Texas Department of Transportation

Modified from: Integral Consulting Inc. and Anchor QEA, LLC. 2013. Remedial Investigation Report, San Jacinto River Waste Pits Superfund Site.
Prepared for: McGinnes Industrial Maintenance Corporation, International Paper Company, and U.S. Environmental Protection Agency, Region 6. May.

Table 3
Results of Groundwater Sampling North of I-10

	GWB study_loc_id sample_date x y GW ^{GW} Class3	C	C	C	A	A	A	B
		SJMWD01	SJMWD02	SJMWD03	SJMWS01	SJMWS02	SJMWS03	SJMWS04
		1/8/2011	1/5/2011	1/7/2011	1/8/2011	1/5/2011	1/7/2011	12/28/2011
		3216668.348	3217045.488	3217179.409	3216654.641	3217048.206	3217163.239	3216943.21
		13857340.83	13857702.27	13857082.67	13857356.47	13857716.27	13857082.92	13857673.38
PhysChem (mg/L)								
TSS		2.5 U	6.5	2.5 U	2.5 U	42	23	14
Metals (mg/L)								
Aluminum	7,300	0.056	0.12	0.17	0.043 J	0.205	0.12	0.48
Arsenic	1	0.0092	0.005	0.0016	0.0086	0.0073	0.0063	0.0075
Barium	200	0.15	0.52	0.45	0.19	0.21	3.8	0.47
Cadmium	0.5	0.0016 J	0.001 U	0.001 U	0.001 U	0.00265 J	0.001 U	0.0029 J
Chromium	10	0.001 U	0.001 U	0.001 U	0.001 U	0.0016 J	0.005 J	0.022
Cobalt	2.2	0.0017	0.002	0.00026	0.00038	0.00165	0.0031	0.0033
Copper	130	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.0037 J
Lead	1.5	1.7E-05 J	8.40E-05	0.00011	2.4E-05 J	0.000245	0.00015	0.0032
Magnesium	—	490	210	38	350	330	330	370
Manganese	1,000	1.9	1.4	0.12	1.7	2	4.4	2
Mercury	0.2	1E-05 UJ	1E-05 UJ	1E-05 UJ	1E-05 UJ	1E-05 UJ	1E-05 UJ	0.00017 J
Nickel	150	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.078
Thallium	0.2	5E-06 U	5.30E-05	1.9E-05 J	5E-06 U	0.00022	8E-06 U	5E-06 U
Vanadium	0.51	3E-05 U	0.0005	0.0015	6E-05 U	0.000595	0.0024	0.0011
Zinc	2,200	0.0004 UJ	0.0054 J	0.0004 UJ	0.0004 UJ	0.0041 U	0.0004 UJ	0.14
Dissolved Metals (mg/L)								
Aluminum	—	0.05 J	0.048 J	0.015 U	0.037 J	0.058	0.031 J	0.052
Arsenic	—	0.0095	0.0049	0.0019	0.0085	0.00695	0.0072	0.0073
Barium	—	0.15	0.56	0.45	0.19	0.215	3.8	0.45
Cadmium	—	0.001 U	0.001 U	0.001 U	0.001 U	0.0026 J	0.002 J	0.0022 J
Chromium	—	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.0028 J	0.001 U
Cobalt	—	0.0017	0.0019	0.00025	0.00035	0.00155	0.0031	0.0007
Copper	—	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Lead	—	5.5E-06 U	2.4E-05 J	5E-06 U	5E-06 U	2.1E-05 J	3E-05 J	1.9E-05 J
Magnesium	—	490	210	37	350	330	330	370
Manganese	—	2	1.5	0.11	1.7	2	4.4	2
Mercury	—	1E-05 UJ	1E-05 UJ	1E-05 UJ	1E-05 UJ	1E-05 UJ	1E-05 UJ	1E-05 U
Nickel	—	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.0093 J
Thallium	—	5E-06 U	9.5E-06 U	8.5E-06 U	5.5E-06 U	1.1E-05 U	5.5E-06 U	5E-06 UJ
Vanadium	—	3E-05 U	0.0002 J	0.0014	3E-05 U	3E-05 U	0.0022	0.00023 J
Zinc	—	0.0004 UJ	0.0004 UJ	0.0004 UJ	0.0004 UJ	0.0004 UJ	0.0004 UJ	0.0004 UJ

Table 3
Results of Groundwater Sampling North of I-10

	GWBU	C	C	C	A	A	A	B
	study_loc_id	SJMWD01	SJMWD02	SJMWD03	SJMWS01	SJMWS02	SJMWS03	SJMWS04
	sample_date	1/8/2011	1/5/2011	1/7/2011	1/8/2011	1/5/2011	1/7/2011	12/28/2011
	x y	3216668.348 13857340.83	3217045.488 13857702.27	3217179.409 13857082.67	3216654.641 13857356.47	3217048.206 13857716.27	3217163.239 13857082.92	3216943.21 13857673.38
Semivolatile Organic Compounds (µg/L)								
Acenaphthene	440,000	0.013 U	0.013 U	0.013 U	0.013 U	0.013 U	0.013 U	0.013 U
Fluorene	290,000	0.014 U	0.014 U	0.014 U	0.014 U	0.014 U	0.014 U	0.03 J
Naphthalene	150,000	0.031 J	0.011 U	0.011 U	0.025 J	0.0295 J	0.033 J	0.046 J
Phenanthrene	220,000	0.011 U	0.029 J	0.011 U	0.011 U	0.011 U	0.011 U	0.099 J
Bis(2-ethylhexyl)phthalat	600	0.065 U	0.065 U	0.065 U	0.065 U	0.0975 J	0.065 U	0.49 J
Phenol	2,200,000	0.032 U	0.07 J	0.14 J	0.032 U	0.0795 J	0.032 U	1.1
Carbazole	10,000	0.009 U	0.009 U	0.009 U	0.009 U	0.018 J	0.009 U	0.054 J
PCBs (pg/L)								
Aroclor 1016	--	480 U	480 U	2,400 U	480 U	480 U	480 U	40,000 U
Aroclor 1221	--	480 U	480 U	20,000 U	480 U	480 U	480 U	95,000 U
Aroclor 1232	--	480 U	480 U	4,800 U	480 U	480 U	480 U	85,000 U
Aroclor 1242	--	480 U	480 U	2,900 U	480 U	480 U	480 U	75,000 U
Aroclor 1248	--	480 U	480 U	2,700 U	480 U	480 U	480 U	28,000 U
Aroclor 1254	--	480 U	480 U	480 U	480 U	480 U	480 U	31,000 U
Aroclor 1260	--	480 U	480 U	480 U	480 U	480 U	480 U	19,000 U
Aroclor 1262	--	480 U	480 U	480 U	480 U	480 U	480 U	480 U
Aroclor 1268	--	480 U	480 U	480 U	480 U	480 U	480 U	480 U
Total PCBs (Aroclor sum)	50,000,000	2,200 U	2,200 U	17,000 U	2,200 U	2,200 U	2,200 U	190,000 U
Dioxin/Furans (pg/L)								
2,3,7,8-TCDD	--	0.44 U	0.58 U	0.51 U	0.52 U	0.44 U	0.37 U	2,700
1,2,3,7,8-PeCDD	--	0.42 U	0.42 U	0.47 U	0.41 U	0.41 U	0.39 U	25 J
1,2,3,4,7,8-HxCDD	--	0.34 U	0.36 U	0.32 U	0.32 U	0.31 U	0.28 U	0.31 U
1,2,3,6,7,8-HxCDD	--	0.47 U	0.52 U	0.45 U	0.43 U	0.46 U	0.4 U	0.48 U
1,2,3,7,8,9-HxCDD	--	0.38 U	0.41 U	0.36 U	0.35 U	0.36 U	0.32 U	0.37 U
1,2,3,4,6,7,8-HpCDD	--	0.37 U	0.49 U	0.4 U	0.44 U	0.41 U	0.35 U	25 J
OCDD	--	1.1 U	0.79 U	0.62 U	0.55 U	3.6 J	7.2 U	390
2,3,7,8-TCDF	--	0.5 U	0.52 U	0.45 U	0.54 U	1.89 J	0.43 U	9,100
1,2,3,7,8-PeCDF	--	0.34 U	0.54 U	0.36 U	0.41 U	0.32 U	0.37 U	270
2,3,4,7,8-PeCDF	--	0.31 U	0.5 U	0.34 U	0.39 U	0.31 U	0.34 U	170
1,2,3,4,7,8-HxCDF	--	0.22 U	0.32 U	0.23 U	0.25 U	0.26 U	0.3 U	520
1,2,3,6,7,8-HxCDF	--	0.22 U	0.31 U	0.23 U	0.25 U	0.26 U	0.3 U	110
1,2,3,7,8,9-HxCDF	--	0.3 U	0.43 U	0.31 U	0.34 U	0.34 U	0.4 U	2.5 U
2,3,4,6,7,8-HxCDF	--	0.23 U	0.33 U	0.25 U	0.26 U	0.27 U	0.31 U	14 J
1,2,3,4,6,7,8-HpCDF	--	0.27 U	0.41 U	0.32 U	0.35 U	0.34 U	0.32 U	120
1,2,3,4,7,8,9-HpCDF	--	0.48 U	0.66 U	0.54 U	0.58 U	0.51 U	0.51 U	50

Table 3
Results of Groundwater Sampling North of I-10

	GWBU	C	C	C	A	A	A	B
	study_loc_id	SJMWD01	SJMWD02	SJMWD03	SJMWS01	SJMWS02	SJMWS03	SJMWS04
	sample_date	1/8/2011	1/5/2011	1/7/2011	1/8/2011	1/5/2011	1/7/2011	12/28/2011
	x	3216668.348	3217045.488	3217179.409	3216654.641	3217048.206	3217163.239	3216943.21
	y	13857340.83	13857702.27	13857082.67	13857356.47	13857716.27	13857082.92	13857673.38
	GW_{Class3}							
OCDF	--	0.55 U	0.69 U	0.67 U	0.68 U	0.57 U	0.7 U	81 J
TEQ _{DF,M}	3,000	1.24 U	1.5 U	1.37 U	1.35 U	2.64 J	1.17 U	3770

Notes

Bold = Detected concentration is greater than GW_{Class3} screening level. See Section 5.2.2 of the text for a discussion of the determination of site groundwater quality.

Samples SJMWS02-D1 & SJMWS02-D1 are averaged

If values are both ND, the lower detection limit is used.

If one value is ND, that detection limit is used.

TEQ_{DF,M} = Toxicity equivalent for dioxins and furans calculated using mammalian toxicity equivalency factors (Van den Berg et al. 2006).

-- = no standard

GWBU = groundwater bearing unit

J = estimated value

PCB = polychlorinated biphenyl

TSS = total suspended solids

U = compound analyzed, but not detected above detection limit

UJ = compound analyzed, but not detected above estimated detection limit

Modified from: Integral Consulting Inc. and Anchor QEA, LLC. 2013. Remedial Investigation Report, San Jacinto River Waste Pits Superfund Site.

Prepared for: McGinnes Industrial Maintenance Corporation, International Paper Company, and U.S. Environmental Protection Agency, Region 6. May.

Table 4
Summary Statistics for Dioxin and Furan Concentrations in Surface Sediment & Waste Material Samples

Analyte	Number of Samples ^a	Number of Detected Measurements	Detection Frequency	Minimum (ng/kg dw)	Maximum (ng/kg dw)	Mean (ng/kg dw)
2,3,7,8-TCDD	159	119	75%	0.0403	21,500	625
1,2,3,7,8-PeCDD	159	46	29%	0.016	175	6.83
1,2,3,4,7,8-HxCDD	159	53	33%	0.0221	70	1.12
1,2,3,6,7,8-HxCDD	159	93	58%	0.0233	50	1.55
1,2,3,7,8,9-HxCDD	159	91	57%	0.023	165	2.90
1,2,3,4,6,7,8-HpCDD	159	155	97%	0.921	290	33.1
OCDD	159	157	99%	19.4	4,870	869
2,3,7,8-TCDF	159	153	96%	0.0422	95,000	2,010
1,2,3,7,8-PeCDF	159	86	54%	0.00875	8,880	109
2,3,4,7,8-PeCDF	159	80	50%	0.0114	3,360	58.2
1,2,3,4,7,8-HxCDF	159	111	70%	0.00555	9,650	152
1,2,3,6,7,8-HxCDF	159	86	54%	0.0054	1,790	33.6
1,2,3,7,8,9-HxCDF	159	25	16%	0.00865	290	5.14
2,3,4,6,7,8-HxCDF	159	52	33%	0.00575	478	8.53
1,2,3,4,6,7,8-HpCDF	159	138	87%	0.0165	1,000	36.6
1,2,3,4,7,8,9-HpCDF	159	57	36%	0.0106	364	13.2
OCDF	159	145	91%	0.053	650	47.3
TEQ _{DF,M}	159	159	100%	0.129	31,600	875

Notes

For all calculations, concentrations below the detection limit were set to one-half the detection limit.

TEQ_{DF,M} (ND=1/2DL) = Toxicity equivalent for 2,3,7,8-TCDD calculated using dioxins and furans and mammalian toxicity equivalency factors (Van den Berg et al. 2006) with non detects set at one-half the detection limit.

dw = dry weight

USEPA = U.S. Environmental Protection Agency

a - The number of samples used in these calculations may differ from numbers shown in other tables because of the criteria used to select data. For this analysis, "surface sediment" samples were those with an upper depth of 0 inches were used, regardless of the total depth.

Modified from: Integral Consulting Inc. and Anchor QEA, LLC. 2013. Remedial Investigation Report, San Jacinto River Waste Pits Superfund Site.
Prepared for: McGinnes Industrial Maintenance Corporation, International Paper Company, and U.S. Environmental Protection Agency, Region 6. May.

Table 5
Summary Statistics for Dioxin and Furan Concentrations in Subsurface Sediment & Waste Material Samples

Analyte	Number of Samples	Number of Detected Measurements	Detection Frequency	Minimum (ng/kg dw)	Maximum (ng/kg dw)	Mean (ng/kg dw)
2,3,7,8-TCDD	135	74	55%	0.0183	18,800	883
1,2,3,7,8-PeCDD	135	52	39%	0.0124	134	6.12
1,2,3,4,7,8-HxCDD	135	52	39%	0.014	2.15	0.292
1,2,3,6,7,8-HxCDD	135	88	65%	0.0135	14.3	1.21
1,2,3,7,8,9-HxCDD	135	95	70%	0.0136	5.59	0.972
1,2,3,4,6,7,8-HpCDD	135	134	99%	0.4	252	33.8
OCDD	135	135	100%	13	6,270	895
2,3,7,8-TCDF	135	98	73%	0.0132	72,900	2,670
1,2,3,7,8-PeCDF	135	56	41%	0.0118	1,700	87.4
2,3,4,7,8-PeCDF	135	59	44%	0.0107	1,050	48.8
1,2,3,4,7,8-HxCDF	135	72	53%	0.0052	2,800	142
1,2,3,6,7,8-HxCDF	135	70	52%	0.00515	671	33.1
1,2,3,7,8,9-HxCDF	135	23	17%	0.0091	35.1	1.60
2,3,4,6,7,8-HxCDF	135	40	30%	0.0056	79.9	4.13
1,2,3,4,6,7,8-HpCDF	135	75	56%	0.00995	804	40.2
1,2,3,4,7,8,9-HpCDF	135	51	38%	0.0172	270	13.2
OCDF	135	84	62%	0.018	702	56.4
TEQ _{DF,M}	132	132	100%	13.7	103,000	4,940

Notes

For all calculations, concentrations below the detection limit were set to one-half the detection limit. TEQ_{DF,M} (ND=1/2DL) = Toxicity equivalent for 2,3,7,8-TCDD calculated using dioxins and furans and mammalian toxicity equivalency factors (Van den Berg et al. 2006) with non detects set at one-half the detection limit.

dw = dry weight

USEPA = U.S. Environmental Protection Agency

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Prepared for: McGinnes Industrial Maintenance Corporation, International Paper Company, and U.S. Environmental Protection Agency, Region 6. May.

Table 6
Summary Statistics for Mercury, Aroclors and Dioxin-Like PCB Concentrations in Surface Sediment & Waste Material Samples

Analyte	Number of Samples	Number of Detected Measurements	Detection Frequency	Minimum	Maximum	Mean
PCB Aroclors (µg/kg dw)						
Aroclor 1016	27	0	0%	9.5	7,000	894
Aroclor 1221	27	0	0%	9.5	15,500	1,520
Aroclor 1232	27	0	0%	9.5	9,000	1,170
Aroclor 1242	27	0	0%	9.5	8,000	1,020
Aroclor 1248	27	0	0%	9.5	3,600	451
Aroclor 1254	27	0	0%	9.5	2,750	276
Aroclor 1260	27	0	0%	9.5	3,100	270
Aroclor 1262	27	0	0%	9.5	1,350	120
Aroclor 1268	27	0	0%	9.5	250	48.6
PCB Congeners (ng/kw dw)						
PCB077	31	19	61%	0.635	2,580	200
PCB081	31	6	19%	0.38	64	7.41
PCB105	31	27	87%	4.37	76,600	5,840
PCB114	31	19	61%	0.374	7,750	440
PCB118	31	26	84%	11.8	197,000	14,800
PCB123	31	19	61%	0.486	4,210	259
PCB126	31	4	13%	0.368	160	15.4
PCB156+157	31	26	84%	2.36	51,400	3,100
PCB167	31	22	71%	0.269	14,900	915
PCB169	31	1	3%	0.28	65	5.53
PCB189	31	14	45%	0.434	1,700	133
TEQ _{P,M}	31	30	97%	0.046	27.5	2.49
Metals (mg/kg dw)						
Mercury	124	118	95%	0.001	2.83	0.126

Notes

For all calculations, concentrations below the detection limit were set to one-half the detection limit. TEQ_{DF,M} (ND=1/2DL) = Toxicity equivalent for 2,3,7,8-TCDD calculated using dioxins and furans and mammalian toxicity equivalency factors (Van den Berg et al. 2006) with non detects set at one-half the detection limit.

TEQ_{P,M} = Toxicity equivalent for TCDD calculated for dioxin-like PCBs using mammalian toxicity equivalency factors (Van den Berg et al. 2006).

dw = dry weight

PCB = polychlorinated biphenyl

USEPA = U.S. Environmental Protection Agency

Modified from: Integral Consulting Inc. and Anchor QEA, LLC. 2013. Remedial Investigation Report, San Jacinto River Waste Pits Superfund Site. Prepared for: McGinnes Industrial Maintenance Corporation, International Paper Company, and U.S. Environmental Protection Agency, Region 6. May.

Table 7
Summary Statistics for Mercury, Aroclors and Dioxin-Like PCB Congener Concentrations in Subsurface Sediment Samples

Analyte	Number of Samples	Number of Detected Measurements	Detection Frequency	Minimum	Maximum	Mean
PCB Aroclors (µg/kg dw)						
Aroclor 1016	32	0	0%	9.5	15,000	2,710
Aroclor 1221	32	0	0%	9.5	26,500	4,460
Aroclor 1232	32	0	0%	9.5	26,500	4,520
Aroclor 1242	32	0	0%	9.5	17,000	2,940
Aroclor 1248	32	0	0%	9.5	6,500	1,040
Aroclor 1254	32	1	3%	9.5	2,250	321
Aroclor 1260	32	0	0%	9.5	2,650	334
Aroclor 1262	32	0	0%	9.5	650	145
Aroclor 1268	32	0	0%	9.5	650	144
Total PCBs (Aroclor sum) (ng/kg dw)	8	8	100%	1,350	61,200	17,500
PCB Congeners (ng/kw dw)						
PCB077	40	21	53%	0.246	1,400	189
PCB081	40	5	13%	0.244	91.3	12.3
PCB105	40	29	73%	0.695	69,000	6,360
PCB114	40	18	45%	0.29	3,720	347
PCB118	40	26	65%	2.77	158,000	15,100
PCB123	40	17	43%	0.296	1,980	193
PCB126	40	5	13%	0.28	203	19.0
PCB156+157	40	27	68%	0.263	28,600	2,590
PCB167	40	24	60%	0.182	8,310	770
PCB169	40	0	0%	0.206	675	41.4
PCB189	40	15	38%	0.264	1,850	160
TEQ _{P,M}	40	32	80%	0.0357	38.1	3.96
Metals (mg/kg dw)						
Mercury	132	128	97%	0.001	2.72	0.157

Notes

For all calculations, concentrations below the detection limit were set to one-half the detection limit. TEQ_{DF,M} (ND=1/2DL) =

Toxicity equivalent for 2,3,7,8-TCDD calculated using dioxins and furans and mammalian toxicity equivalency factors (Van den Berg et al. 2006) with non detects set at one-half the detection limit.

TEQ_{P,M} = Toxicity equivalent for TCDD calculated for dioxin-like PCBs using mammalian toxicity equiivalency factors (Van den Berg et al. 2006).

dw = dry weight

PCB = polychlorinated biphenyl

USEPA = U.S. Environmental Protection Agency

Modified from: Integral Consulting Inc. and Anchor QEA, LLC. 2013. Remedial Investigation Report, San Jacinto River Waste Pits Superfund Site.
Prepared for: McGinnes Industrial Maintenance Corporation, International Paper Company, and U.S. Environmental Protection Agency, Region 6. May.

Table 8
Summary Statistics for Dioxins, Furans, PCBs, and Mercury in Edible Blue Crab Tissue from FCAs

	FCA1					FCA2					FCA3					Background				
	Detection Frequency	Minimum Detected Value	Maximum Detected Value	Mean ^a	Median ^a	Detection Frequency	Minimum Detected Value	Maximum Detected Value	Mean ^a	Median ^a	Detection Frequency	Minimum Detected Value	Maximum Detected Value	Mean ^a	Median ^a	Detection Frequency	Minimum Detected Value	Maximum Detected Value	Mean ^a	Median ^a
Blue Crab - Edible																				
Dioxins and Furans (ng/kg ww)																				
2,3,7,8-TCDD	5/10	0.513	1.43	0.523	0.371	2/10	0.134	0.416	0.126	0.105	0/10	--	--	0.0608	0.0615	1/20	0.0187	0.512	0.0701	0.0437
1,2,3,7,8-PeCDD	0/10	--	--	0.0402	0.0293	0/10	--	--	0.028	0.028	0/10	--	--	0.0333	0.0276	0/20	0.0182	0.0725	0.0404	0.0354
1,2,3,4,7,8-HxCDD	0/10	--	--	0.0248	0.0254	0/10	--	--	0.023	0.023	0/10	--	--	0.025	0.0223	0/20	0.0151	0.0825	0.0327	0.0293
1,2,3,6,7,8-HxCDD	2/10	0.0773	0.184	0.0534	0.0395	0/10	--	--	0.03	0.0305	0/10	--	--	0.0311	0.0278	0/20	0.0202	0.105	0.0413	0.0387
1,2,3,7,8,9-HxCDD	1/10	0.191	0.191	0.0435	0.0279	0/10	--	--	0.0256	0.0259	0/10	--	--	0.027	0.0238	0/20	0.0171	0.0920	0.0358	0.0327
1,2,3,4,6,7,8-HpCDD	7/10	0.102	0.348	0.134	0.117	1/10	0.0962	0.0962	0.0347	0.0254	0/10	--	--	0.0282	0.0257	1/20	0.0177	0.189	0.0485	0.0336
OCDD	5/10	0.443	2.51	0.645	0.407	5/10	0.23	1.27	0.329	0.197	0/10	--	--	0.0962	0.089	3/20	0.0560	0.495	0.207	0.171
2,3,7,8-TCDF	9/10	0.52	3.31	1.39	1.26	8/10	0.359	1.07	0.504	0.464	4/10	0.242	0.787	0.238	0.158	0/20	0.0275	0.823	0.104	0.0477
1,2,3,7,8-PeCDF	0/10	--	--	0.0289	0.0286	0/10	--	--	0.0258	0.0253	0/10	--	--	0.0309	0.03	0/20	0.0150	0.0815	0.0369	0.0327
2,3,4,7,8-PeCDF	0/10	--	--	0.0276	0.0268	0/10	--	--	0.0257	0.0252	0/10	--	--	0.0295	0.0291	0/20	0.0140	0.0740	0.0349	0.0309
1,2,3,4,7,8-HxCDF	1/10	0.199	0.199	0.0376	0.0179	0/10	--	--	0.0185	0.0177	0/10	--	--	0.0208	0.019	0/20	0.0171	0.0835	0.0290	0.0242
1,2,3,6,7,8-HxCDF	3/10	0.0622	0.16	0.0442	0.0213	0/10	--	--	0.0181	0.0172	0/10	--	--	0.0197	0.0179	0/20	0.0164	0.0765	0.0273	0.0230
1,2,3,7,8,9-HxCDF	0/10	--	--	0.0276	0.0191	0/10	--	--	0.0244	0.0225	0/10	--	--	0.0257	0.0235	0/20	0.0179	0.132	0.0380	0.0311
2,3,4,6,7,8-HxCDF	1/10	0.134	0.134	0.0315	0.0181	0/10	--	--	0.0202	0.0189	0/10	--	--	0.0212	0.0193	0/20	0.0173	0.0855	0.0303	0.0248
1,2,3,4,6,7,8-HpCDF	0/10	--	--	0.0319	0.0259	0/10	--	--	0.0195	0.0194	0/10	--	--	0.0265	0.0283	0/20	0.0143	0.0840	0.0307	0.0277
1,2,3,4,7,8,9-HpCDF	0/10	--	--	0.0377	0.0335	0/10	--	--	0.0282	0.0277	0/10	--	--	0.0387	0.0393	0/20	0.0203	0.124	0.0404	0.0380
OCDF	4/10	0.112	0.53	0.15	0.084	0/10	--	--	0.042	0.041	0/10	--	--	0.0577	0.054	1/20	0.0332	0.210	0.0757	0.0660
TEQ _{DF,M}	10/10	0.229	1.91	0.739	0.554	8/10	0.139	0.558	0.23	0.199	4/10	0.0921	0.271	0.146	0.151	6/20	0.0726	0.639	0.157	0.119
TEQ _{DFP,M}	10/10	0.355	1.99	0.858	0.641	10/10	0.288	0.891	0.472	0.428	10/10	0.233	0.396	0.286	0.273	10/10	0.111	0.28	0.2	0.190
TEQ _{p,M}	10/10	0.0654	0.234	0.119	0.107	10/10	0.115	0.547	0.242	0.212	10/10	0.0688	0.303	0.14	0.147	10/10	0.0382	0.169	0.0907	0.0910
Polychlorinated Biphenyls (µg/kg ww)																				
Total PCBs ^b	10/10	0.554	5.86	1.97	1.35	10/10	4.6	13.5	7.44	6.58	10/10	2.94	9.06	5.04	4.22	10/10	0.547	2.13	1.29	1.39
Metals (mg/kg ww)																				
Mercury	10/10	0.0419	0.0652	0.0527	0.0531	10/10	0.0171	0.0498	0.0292	0.0245	10/10	0.0276	0.0522	0.0386	0.0354	10/10	0.0149	0.0364	0.0205	0.0189

Notes

- FCA = fish collection area
- PCB = polychlorinated biphenyl
- TEQ_{DF,M} = Toxicity equivalent for dioxins and furans calculated using mammalian toxicity equivalency factors (van den Berg et al. 2006) with nondetects set at one-half the detection limit.
- TEQ_{DFP,M} = Toxicity equivalent for dioxins, furans and polychlorinated biphenyls calculated using mammalian toxicity equivalency factors (Van den Berg et al. 2006) with nondetects set at one-half the detection limit.
- TEQ_{p,M} - Toxicity equivalent for polychlorinated biphenyls calculated using mammalian toxicity equivalency factors with nondetects set at one-half the detection limit. Data for individual congeners are presented in Appendix B.
- USEPA = U.S. Environmental Protection Agency
- ww = wet weight
- = Not applicable, no detected values
- a - Mean and median calculations include detected and nondetected values. Nondetected values were set at one-half the detection limit.
- b - Total PCBs were calculated using all 209 PCB congeners with non-detects set at one-half the detection limit.

Modified from: Integral Consulting Inc. and Anchor QEA, LLC. 2013. Remedial Investigation Report, San Jacinto River Waste Pits Superfund Site.
Prepared for: McGinnes Industrial Maintenance Corporation, International Paper Company, and U.S. Environmental Protection Agency, Region 6. May.

Table 9
Summary Statistics for Dioxins, Furans, PCBs, and Mercury in Hardhead Catfish Fillet Tissue from FCAs

	FCA1					FCA2					FCA3					Background				
	Detection Frequency	Minimum Detected Value	Maximum Detected Value	Mean ^a	Median ^a	Detection Frequency	Minimum Detected Value	Maximum Detected Value	Mean ^a	Median ^a	Detection Frequency	Minimum Detected Value	Maximum Detected Value	Mean ^a	Median ^a	Detection Frequency	Minimum Detected Value	Maximum Detected Value	Mean ^a	Median ^a
Catfish - Fillet																				
Dioxins and Furans (ng/kg ww)																				
2,3,7,8-TCDD	10/10	0.755	5.03	2.77	2.71	10/10	2.38	5.35	3.6	3.47	10/10	1.5	4.63	2.97	2.85	10/20	0.0965	3.60	0.622	0.241
1,2,3,7,8-PeCDD	2/10	0.163	0.174	0.063	0.0289	4/10	0.108	0.216	0.0978	0.066	4/10	0.183	0.334	0.130	0.0528	5/20	0.0151	0.625	0.118	0.0593
1,2,3,4,7,8-HxCDD	2/10	0.0431	0.0642	0.0242	0.0178	3/10	0.0705	0.103	0.0395	0.0251	3/10	0.0657	0.266	0.0696	0.0299	11/20	0.0130	0.794	0.127	0.0535
1,2,3,6,7,8-HxCDD	6/10	0.134	0.608	0.2	0.153	6/10	0.188	0.704	0.256	0.193	5/10	0.222	1.69	0.476	0.183	11/20	0.0257	2.55	0.376	0.170
1,2,3,7,8,9-HxCDD	4/10	0.0444	0.2	0.0554	0.0413	0/10	--	--	0.0409	0.0278	4/10	0.0558	0.604	0.145	0.0438	7/20	0.0156	0.721	0.141	0.0495
1,2,3,4,6,7,8-HpCDD	1/10	0.845	0.845	0.222	0.167	0/10	--	--	0.239	0.208	2/10	2.44	3.40	0.801	0.247	8/20	0.0895	4.26	0.801	0.277
OCDD	0/10	--	--	0.436	0.455	0/10	--	--	0.558	0.543	0/10	--	--	1.02	0.67	0/20	0.202	10.3	1.99	0.665
2,3,7,8-TCDF	6/10	0.279	1.03	0.319	0.283	9/10	0.404	1.46	0.779	0.687	8/10	0.396	1.27	0.579	0.582	3/20	0.0164	1.10	0.158	0.0615
1,2,3,7,8-PeCDF	0/10	--	--	0.0229	0.0234	1/10	0.0904	0.0904	0.0291	0.021	0/10	--	--	0.0269	0.0276	1/20	0.00940	0.170	0.0320	0.0224
2,3,4,7,8-PeCDF	3/10	0.198	0.335	0.111	0.0658	5/10	0.123	0.300	0.157	0.146	3/10	0.163	0.402	0.158	0.13	5/20	0.0143	0.590	0.0983	0.0313
1,2,3,4,7,8-HxCDF	0/10	--	--	0.0146	0.0146	1/10	0.0504	0.0504	0.0219	0.0193	1/10	0.0794	0.0794	0.0236	0.0182	1/20	0.00895	0.0920	0.0227	0.0158
1,2,3,6,7,8-HxCDF	0/10	--	--	0.0139	0.0138	0/10	--	--	0.0173	0.0171	0/10	--	--	0.0166	0.0171	2/20	0.00850	0.125	0.0261	0.0136
1,2,3,7,8,9-HxCDF	0/10	--	--	0.0185	0.0184	0/10	--	--	0.0216	0.0215	0/10	--	--	0.0199	0.0189	0/20	0.0108	0.107	0.0256	0.0184
2,3,4,6,7,8-HxCDF	0/10	--	--	0.0154	0.0153	0/10	--	--	0.0201	0.0199	0/10	--	--	0.0181	0.0182	0/20	0.00945	0.101	0.0224	0.0149
1,2,3,4,6,7,8-HpCDF	0/10	--	--	0.0182	0.017	0/10	--	--	0.0191	0.0186	0/10	--	--	0.0197	0.0199	1/20	0.0104	0.0671	0.0266	0.0228
1,2,3,4,7,8,9-HpCDF	0/10	--	--	0.0272	0.0255	0/10	--	--	0.0265	0.0264	0/10	--	--	0.0259	0.0242	0/20	0.0141	0.0645	0.0291	0.0299
OCDF	0/10	--	--	0.0494	0.0415	0/10	--	--	0.0357	0.0343	0/10	--	--	0.0573	0.0316	3/20	0.0197	0.943	0.108	0.0490
TEQ _{DF,M}	10/10	0.801	5.45	2.94	2.81	10/10	2.58	5.85	3.87	3.66	10/10	1.60	5.32	3.29	3.02	18/20	0.142	4.97	0.865	0.373
TEQ _{DFF,M}	10/10	1.26	6.71	4.21	4.06	10/10	3.33	7.14	5.15	5.33	10/10	1.91	8.12	4.66	4.25	10/10	0.504	1.19	0.719	0.649
TEQ _{P,M}	10/10	0.457	2.27	1.28	1.15	10/10	0.573	2.03	1.28	1.29	10/10	0.282	2.79	1.36	1.29	10/10	0.223	0.804	0.48	0.571
Polychlorinated Biphenyls (µg/kg ww)																				
Total PCBs ^b	10/10	22.2	159	97.7	91.9	10/10	64.6	158	99.7	97.2	10/10	29.8	152	107	119	10/10	25.4	88.4	46.5	37.4
Metals (mg/kg ww)																				
Mercury	10/10	0.104	0.266	0.159	0.137	10/10	0.069	0.264	0.114	0.0942	10/10	0.0408	0.188	0.0856	0.075	10/10	0.0801	0.197	0.126	0.117

Notes
FCA = fish collection area
PCB = polychlorinated biphenyl
TEQ_{DF,M} = Toxicity equivalent for dioxins and furans calculated using mammalian toxicity equivalency factors (Van den Berg et al. 2006) with nondetects set at one-half the detection limit.
TEQ_{DFF,M} = Toxicity equivalent for dioxins, furans and polychlorinated biphenyls calculated using mammalian toxicity equivalency factors (Van den Berg et al. 2006) with nondetects set at one-half the detection limit.
TEQ_{P,M} - Toxicity equivalent for polychlorinated biphenyls calculated using mammalian toxicity equivalency factors (Van den Berg et al. 2006) with nondetects set at one-half the detection limit. Data for individual congeners are presented in Appendix B.
USEPA = U.S. Environmental Protection Agency
ww = wet weight
-- = Not applicable, no detected values

a - Mean and median calculations include detected and nondetected values. Nondetected values were set at one-half the detection limit.
b - Total PCBs were calculated using all 209 PCB congeners with non-detects set at one-half the detection limit.

Modified from: Integral Consulting Inc. and Anchor QEA, LLC. 2013. Remedial Investigation Report, San Jacinto River Waste Pits Superfund Site.
Prepared for: McGinnes Industrial Maintenance Corporation, International Paper Company, and U.S. Environmental Protection Agency, Region 6. May.

Table 10
Summary Statistics for Dioxins, Furans, PCBs, and Mercury in Edible Common Rangia (Clam) Tissue from FCAs

	FCA1					FCA2					FCA3					Upstream Background				
	Detection Frequency	Minimum Detected Value	Maximum Detected Value	Mean ^a	Median ^a	Detection Frequency	Minimum Detected Value	Maximum Detected Value	Mean ^a	Median ^a	Detection Frequency	Minimum Detected Value	Maximum Detected Value	Mean ^a	Median ^a	Detection Frequency	Minimum Detected Value	Maximum Detected Value	Mean ^a	Median ^a
Clam - Edible																				
Dioxins and Furans (ng/kg ww)																				
2,3,7,8-TCDD	4/5	1.31	1.50	1.19	1.37	13/15	0.519	17.6	5	1.98	3/5	0.647	0.784	0.479	0.647	1/10	0.454	0.454	0.152	0.097
1,2,3,7,8-PeCDD	0/5	--	--	0.0303	0.0295	0/15	--	--	0.03	0.0261	0/5	--	--	0.0532	0.054	0/10	--	--	0.045	0.0424
1,2,3,4,7,8-HxCDD	0/5	--	--	0.0255	0.0234	0/15	--	--	0.0388	0.0377	0/5	--	--	0.0517	0.0565	0/10	--	--	0.0368	0.035
1,2,3,6,7,8-HxCDD	0/5	--	--	0.0317	0.0292	1/15	0.727	0.727	0.0912	0.0465	0/5	--	--	0.0669	0.073	0/10	--	--	0.0488	0.0461
1,2,3,7,8,9-HxCDD	0/5	--	--	0.0278	0.0255	1/15	0.468	0.468	0.0691	0.041	0/5	--	--	0.055	0.06	0/10	--	--	0.0403	0.0382
1,2,3,4,6,7,8-HpCDD	3/5	0.882	1.17	0.734	0.882	8/15	0.22	26.1	2.01	0.271	3/5	0.247	0.469	0.314	0.263	6/10	0.406	0.554	0.37	0.408
OCDD	5/5	3.02	8.38	6.51	7.14	13/15	1.31	182	15.3	3.67	5/5	2.01	5.30	3.70	4.24	10/10	3.85	6.22	4.84	4.85
2,3,7,8-TCDF	4/5	2.98	6.03	4.31	4.61	15/15	2.72	89.6	27	10.8	5/5	1.38	3.70	2.47	2.80	9/10	0.498	2.31	1.22	1.28
1,2,3,7,8-PeCDF	0/5	--	--	0.0287	0.0314	2/15	0.358	0.692	0.16	0.0468	0/5	--	--	0.0459	0.047	0/10	--	--	0.0387	0.0365
2,3,4,7,8-PeCDF	0/5	--	--	0.0347	0.0315	3/15	0.591	0.884	0.193	0.0456	0/5	--	--	0.0436	0.044	0/10	--	--	0.0386	0.0371
1,2,3,4,7,8-HxCDF	0/5	--	--	0.0315	0.0313	2/15	0.686	1.36	0.191	0.0334	0/5	--	--	0.0528	0.0505	0/10	--	--	0.0311	0.0305
1,2,3,6,7,8-HxCDF	0/5	--	--	0.0303	0.0302	2/15	0.201	0.691	0.0808	0.0242	0/5	--	--	0.0495	0.0494	0/10	--	--	0.0295	0.029
1,2,3,7,8,9-HxCDF	0/5	--	--	0.0494	0.0483	0/15	--	--	0.042	0.0369	0/5	--	--	0.0686	0.069	0/10	--	--	0.0411	0.0419
2,3,4,6,7,8-HxCDF	0/5	--	--	0.0359	0.0342	1/15	0.611	0.611	0.0643	0.0275	0/5	--	--	0.0567	0.0555	0/10	--	--	0.0345	0.0334
1,2,3,4,6,7,8-HpCDF	0/5	--	--	0.0356	0.0317	1/15	10.2	10.2	0.712	0.0321	0/5	--	--	0.0443	0.0451	0/10	--	--	0.0353	0.0359
1,2,3,4,7,8,9-HpCDF	0/5	--	--	0.0497	0.0452	1/15	1.10	1.10	0.118	0.045	0/5	--	--	0.0588	0.0605	0/10	--	--	0.05	0.0518
OCDF	0/5	--	--	0.069	0.0525	1/15	45.4	45.4	3.08	0.0474	0/5	--	--	0.115	0.114	0/10	--	--	0.0732	0.0715
TEQ _{DF,M}	5/5	0.718	2.19	1.7	1.9	15/15	0.854	27.0	7.89	3.61	5/5	0.371	1.29	0.838	1.05	10/10	0.173	0.702	0.364	0.341
TEQ _{DFP,M}	5/5	0.940	2.42	1.92	2.06	15/15	1.26	27.6	8.39	3.86	5/5	0.666	1.64	1.2	1.49	10/10	0.296	0.902	0.545	0.479
TEQ _{P,M}	5/5	0.156	0.271	0.22	0.225	15/15	0.202	1.90	0.502	0.376	5/5	0.279	0.436	0.366	0.367	10/10	0.118	0.283	0.181	0.175
Polychlorinated Biphenyls (µg/kg ww)																				
Total PCBs ^b	5/5	20.4	25.6	23.6	23.7	15/15	20.2	95.4	46.1	30.8	5/5	30.4	40.8	34.1	34	10/10	9.54	17.8	12.9	11.7
Metals (mg/kg ww)																				
Mercury	5/5	0.0066	0.0124	0.00942	0.0092	13/15	0.0042	0.0154	0.0096	0.0104	5/5	0.0106	0.0178	0.0127	0.012	10/10	0.0046	0.008	0.0062	0.00615

Notes
FCA = fish collection area
PCB = polychlorinated biphenyl
TEQ_{DF,M} = Toxicity equivalent for dioxins and furans calculated using mammalian toxicity equivalency factors (Van den Berg et al. 2006) with nondetects set at one-half the detection limit.
TEQ_{DFP,M} = Toxicity equivalent for dioxins, furans and polychlorinated biphenyls calculated using mammalian toxicity equivalency factors (Van den Berg et al. 2006) with nondetects set at one-half the detection limit.
TEQ_{P,M} - Toxicity equivalent for polychlorinated biphenyls calculated using mammalian toxicity equivalency factors (Van den Berg et al. 2006) with nondetects set at one-half the detection limit. Data for individual congeners are presented in Appendix B.
USEPA = U.S. Environmental Protection Agency
ww = wet weight
-- = Not applicable, no detected value

a - Mean and median calculations include detected and nondetected values. Nondetected values were set at one-half the detection limit.
b - Total PCBs were calculated using all 209 PCB congeners with non-detects set at one-half the detection limit.

Table 11
Summary Statistics for Dioxins, Furans, PCBs, and Mercury in Whole Gulf Killifish Tissue from FCAs

	FCA1					FCA2					FCA3					Upstream Background				
	Detection Frequency	Minimum Detected Value	Maximum Detected Value	Mean ^a	Median ^a	Detection Frequency	Minimum Detected Value	Maximum Detected Value	Mean ^a	Median ^a	Detection Frequency	Minimum Detected Value	Maximum Detected Value	Mean ^a	Median ^a	Detection Frequency	Minimum Detected Value	Maximum Detected Value	Mean ^a	Median ^a
Gulf Killifish - Whole																				
Dioxins and Furans (ng/kg ww)																				
2,3,7,8-TCDD	0/2	--	--	0.0761	0.0761	3/6	0.808	9.53	2.48	0.504	0/2	--	--	0.217	0.217	0/8	--	--	0.0685	0.0544
1,2,3,7,8-PeCDD	0/2	--	--	0.0101	0.0101	0/6	--	--	0.0132	0.0138	0/2	--	--	0.0703	0.0703	0/8	--	--	0.0247	0.0169
1,2,3,4,7,8-HxCDD	0/2	--	--	0.012	0.0119	0/6	--	--	0.0138	0.0121	0/2	--	--	0.0324	0.0324	0/8	--	--	0.0205	0.0182
1,2,3,6,7,8-HxCDD	0/2	--	--	0.0134	0.0133	0/6	--	--	0.0155	0.0137	0/2	--	--	0.0431	0.0431	0/8	--	--	0.0254	0.0209
1,2,3,7,8,9-HxCDD	0/2	--	--	0.0123	0.0123	0/6	--	--	0.0142	0.0125	0/2	--	--	0.0351	0.0351	0/8	--	--	0.0218	0.0191
1,2,3,4,6,7,8-HpCDD	0/2	--	--	0.0218	0.0218	4/6	0.0868	0.147	0.0964	0.0916	2/2	0.429	0.663	0.546	0.546	6/8	0.114	0.381	0.200	0.220
OCDD	0/2	--	--	0.195	0.195	1/6	1.43	1.43	0.569	0.431	2/2	4.15	4.30	4.23	4.23	4/8	1.53	4.55	2.22	1.50
2,3,7,8-TCDF	0/2	--	--	0.0369	0.0369	4/6	0.618	4.46	1.69	1.19	2/2	0.505	0.850	0.678	0.678	2/8	0.304	0.444	0.132	0.0873
1,2,3,7,8-PeCDF	0/2	--	--	0.0154	0.0154	0/6	--	--	0.0156	0.0115	0/2	--	--	0.0454	0.0454	0/8	--	--	0.0205	0.0184
2,3,4,7,8-PeCDF	0/2	--	--	0.0152	0.0152	1/6	0.188	0.188	0.0787	0.0131	0/2	--	--	0.0461	0.0461	0/8	--	--	0.0201	0.018
1,2,3,4,7,8-HxCDF	0/2	--	--	0.0079	0.00793	1/6	0.266	0.266	0.057	0.0101	0/2	--	--	0.036	0.036	0/8	--	--	0.0162	0.0115
1,2,3,6,7,8-HxCDF	0/2	--	--	0.0074	0.0074	1/6	0.0695	0.0695	0.0191	0.0095	0/2	--	--	0.0346	0.0346	0/8	--	--	0.0157	0.0109
1,2,3,7,8,9-HxCDF	0/2	--	--	0.0085	0.0085	0/6	--	--	0.0097	0.00955	0/2	--	--	0.0492	0.0492	0/8	--	--	0.0203	0.0124
2,3,4,6,7,8-HxCDF	0/2	--	--	0.0078	0.00783	0/6	--	--	0.009	0.00858	0/2	--	--	0.0394	0.0394	0/8	--	--	0.0172	0.0114
1,2,3,4,6,7,8-HpCDF	0/2	--	--	0.0126	0.0126	0/6	--	--	0.015	0.0139	0/2	--	--	0.0423	0.0423	1/8	0.0621	0.0621	0.0282	0.0207
1,2,3,4,7,8,9-HpCDF	0/2	--	--	0.0153	0.0153	0/6	--	--	0.0184	0.0165	0/2	--	--	0.054	0.054	0/8	--	--	0.0285	0.025
OCDF	0/2	--	--	0.014	0.014	0/6	--	--	0.0153	0.0163	0/2	--	--	0.0765	0.0768	1/8	0.341	0.341	0.0763	0.0314
TEQ _{DF,M}	0/2	--	--	0.102	0.102	5/6	0.034	10.1	2.70	0.647	2/2	0.379	0.430	0.404	0.404	7/8	0.0373	0.307	0.13	0.105
TEQ _{DFP,M}	2/2	0.390	0.865	0.627	0.627	6/6	0.264	13.0	3.96	1.40	2/2	0.725	1.10	0.914	0.914	8/8	0.165	0.918	0.424	0.323
TEQ _{P,M}	2/2	0.318	0.732	0.525	0.525	6/6	0.230	2.92	1.26	0.755	2/2	0.346	0.674	0.510	0.510	8/8	0.103	0.653	0.295	0.201
Polychlorinated Biphenyls (µg/kg ww)																				
Total PCBs ^b	2/2	32.7	39.7	36.2	36.2	6/6	18.6	191	82.6	38.1	2/2	28.4	51.9	40.2	40.2	8/8	10.2	14.6	12	11.9
Metals (mg/kg ww)																				
Mercury	2/2	0.0231	0.0328	0.028	0.028	6/6	0.0221	0.09	0.0501	0.0384	2/2	0.0568	0.0762	0.0665	0.0665	8/8	0.0225	0.0694	0.0393	0.0314

Notes

-- = Not applicable, no detected values

FCA = fish collection area

PCB = polychlorinated biphenyl

TEQ_{DF,M} = Toxicity equivalent for dioxins and furans calculated using mammalian toxicity equivalency factors (Van den Berg et al. 2006) with nondetects set at one-half the detection limit.

TEQ_{DFP,M} = Toxicity equivalent for dioxins, furans and polychlorinated biphenyls calculated using mammalian toxicity equivalency factors (Van den Berg et al. 2006) with nondetects set at one-half the detection limit.

TEQ_{P,M} = Toxicity equivalent for polychlorinated biphenyls calculated using mammalian toxicity equivalency factors (Van den Berg et al. 2006) with nondetects set at one-half the detection limit. Data for individual congeners are presented in Appendix B.

USEPA = U.S. Environmental Protection Agency

ww = wet weight

a - Mean and median calculations include detected and nondetected values. Nondetected values were set at one-half the detection limit.

b - Total PCBs were calculated using all 209 PCB congeners with non-detects set at one-half the detection limit.

Modified from: Integral Consulting Inc. and Anchor QEA, LLC. 2013. Remedial Investigation Report, San Jacinto River Waste Pits Superfund Site.
Prepared for: McGinnes Industrial Maintenance Corporation, International Paper Company, and U.S. Environmental Protection Agency, Region 6. May.

Table 12
Summary Statistics for Dioxin and Furan Concentrations in Soil Investigation Area 4 (Southern Impoundment)
and Adjacent Surface Soil Samples

Analyte	Number of Samples	Number of Detected Measurements	Detection Frequency	Concentration (ng/kg dw)		
				Minimum	Maximum	Mean
2,3,7,8-TCDD	ng/kg	24	83%	0.544	24.3	4.84
1,2,3,7,8-PeCDD	ng/kg	23	79%	0.216	3.30	0.766
1,2,3,4,7,8-HxCDD	ng/kg	25	86%	0.186	4.71	1.25
1,2,3,6,7,8-HxCDD	ng/kg	27	93%	0.720	12.6	3.88
1,2,3,7,8,9-HxCDD	ng/kg	29	100%	0.627	12.2	3.59
1,2,3,4,6,7,8-HpCDD	ng/kg	29	100%	19.6	438	149
OCDD	ng/kg	29	100%	376	64,900	9200
2,3,7,8-TCDF	ng/kg	25	86%	0.237	78.7	15.7
1,2,3,7,8-PeCDF	ng/kg	21	72%	0.229	3.72	1.03
2,3,4,7,8-PeCDF	ng/kg	24	83%	0.180	3.48	1.01
1,2,3,4,7,8-HxCDF	ng/kg	29	100%	0.160	8.26	2.64
1,2,3,6,7,8-HxCDF	ng/kg	21	72%	0.229	2.94	0.999
1,2,3,7,8,9-HxCDF	ng/kg	6	21%	0.0696	0.353	0.103
2,3,4,6,7,8-HxCDF	ng/kg	20	69%	0.258	3.60	0.998
1,2,3,4,6,7,8-HpCDF	ng/kg	29	100%	0.870	60.8	14.4
1,2,3,4,7,8,9-HpCDF	ng/kg	22	76%	0.204	4.82	1.20
OCDF	ng/kg	29	100%	3.00	249	66.4
TEQ _{DF,M}	ng/kg	29	100%	1.35	36.9	13.3

Notes

Mean calculations include detected and nondetected values. Nondetected values were set to one-half the detection limit.

TEQ_{DF,M} (ND=1/2DL) = Toxicity equivalent for 2,3,7,8-tetrachlorinated dibenzo-p-dioxin (TCDD) calculated using dioxins and furans and mammalian toxicity equivalency factors (Van den Berg et al. 2006) with nondetects set at one-half the detection limit.

dw = dry weight

Modified from: Integral Consulting Inc. and Anchor QEA, LLC. 2013. Remedial Investigation Report, San Jacinto River Waste Pits Superfund Site.
Prepared for: McGinnes Industrial Maintenance Corporation, International Paper Company, and U.S. Environmental Protection Agency, Region 6. May.

Table 13
Summary Statistics for Dioxin and Furan Concentrations in Soil Investigation Area 4 (Southern Impoundment)
and Adjacent Subsurface Soils Samples

Analyte	Number of Samples	Number of Detected Measurements	Detection Frequency	Concentration (ng/kg dw)		
				Minimum	Maximum	Mean
2,3,7,8-TCDD	ng/kg	176	80%	0.157	33800	398
1,2,3,7,8-PeCDD	ng/kg	145	66%	0.0449	375	4.97
1,2,3,4,7,8-HxCDD	ng/kg	145	66%	0.0226	17.5	1.41
1,2,3,6,7,8-HxCDD	ng/kg	180	81%	0.109	89.6	6.76
1,2,3,7,8,9-HxCDD	ng/kg	184	83%	0.0476	52	4.28
1,2,3,4,6,7,8-HpCDD	ng/kg	217	98%	0.995	2390	211
OCDD	ng/kg	221	100%	5.86	106000	6620
2,3,7,8-TCDF	ng/kg	203	92%	0.347	129000	1470
1,2,3,7,8-PeCDF	ng/kg	166	75%	0.0975	8300	67.7
2,3,4,7,8-PeCDF	ng/kg	165	75%	0.0905	3690	37.2
1,2,3,4,7,8-HxCDF	ng/kg	190	86%	0.109	11300	92.6
1,2,3,6,7,8-HxCDF	ng/kg	154	70%	0.069	3750	30.8
1,2,3,7,8,9-HxCDF	ng/kg	62	28%	0.039	242	1.82
2,3,4,6,7,8-HxCDF	ng/kg	134	61%	0.0763	646	6.70
1,2,3,4,6,7,8-HpCDF	ng/kg	200	90%	0.091	4240	67.8
1,2,3,4,7,8,9-HpCDF	ng/kg	144	65%	0.101	1620	14.8
OCDF	ng/kg	201	91%	0.266	11300	616
TEQ _{DF,M}	ng/kg	221	100%	0.0917	50100	582

Notes

Mean calculations include detected and nondetected values. Nondetected values were set to one-half the detection limit.

TEQ_{DF,M} (ND=1/2DL) = Toxicity equivalent for 2,3,7,8-tetrachlorinated dibenzo-p-dioxin (TCDD) calculated using dioxins and furans and mammalian toxicity equivalency factors (Van den Berg et al. 2006) with nondetects set at one-half the detection limit.

dw = dry weight

Modified from: Integral Consulting Inc. and Anchor QEA, LLC. 2013. Remedial Investigation Report, San Jacinto River Waste Pits Superfund Site. Prepared for: McGinnes Industrial Maintenance Corporation, International Paper Company, and U.S. Environmental Protection Agency, Region 6. May.

Table 14
Summary Statistics for Dioxin and Furan Concentrations in Soil Investigation Area 4 (Southern Impoundment)
and Adjacent Core Soil Samples

Analyte	Number of Samples	Detected Measurements	Detection Frequency	Concentration (ng/kg dw)		
				Minimum	Maximum	Mean
2,3,7,8-TCDD	172	140	81%	0.0314	33,800	509
1,2,3,7,8-PeCDD	172	109	63%	0.00935	375	6.21
1,2,3,4,7,8-HxCDD	172	107	62%	0.00875	17.5	1.52
1,2,3,6,7,8-HxCDD	172	137	80%	0.00865	89.6	7.59
1,2,3,7,8,9-HxCDD	172	138	80%	0.0184	52	4.65
1,2,3,4,6,7,8-HpCDD	172	168	98%	0.135	2,390	233
OCDD	172	172	100%	5.86	106,000	6,690
2,3,7,8-TCDF	172	159	92%	0.049	129,000	1,880
1,2,3,7,8-PeCDF	172	127	74%	0.00505	8,300	86.6
2,3,4,7,8-PeCDF	172	127	74%	0.00575	3,690	47.4
1,2,3,4,7,8-HxCDF	172	144	84%	0.0078	11,300	118
1,2,3,6,7,8-HxCDF	172	120	70%	0.00815	3,750	39.2
1,2,3,7,8,9-HxCDF	172	51	30%	0.0112	242	2.31
2,3,4,6,7,8-HxCDF	172	103	60%	0.0093	646	8.31
1,2,3,4,6,7,8-HpCDF	172	152	88%	0.011	4,240	82.3
1,2,3,4,7,8,9-HpCDF	172	111	65%	0.0148	1,620	18.6
OCDF	172	153	89%	0.0221	11,300	768
TEQ _{DF,M}	172	172	100%	0.0917	50,100	743

Notes

Mean calculations include detected and nondetected values. Nondetected values were set to one-half the detection limit.

TEQ_{DF,M} (ND=1/2DL) = Toxicity equivalent for 2,3,7,8-tetrachlorinated dibenzo-p-dioxin (TCDD)

calculated using dioxins and furans and mammalian toxicity equivalency factors (Van den Berg et al.

2006) with nondetects set at one-half the detection limit.

dw = dry weight

Modified from: Integral Consulting Inc. and Anchor QEA, LLC. 2013. Remedial Investigation Report, San Jacinto River Waste Pits Superfund Site.
Prepared for: McGinnes Industrial Maintenance Corporation, International Paper Company, and U.S. Environmental Protection Agency, Region 6. May.

Table 15
Summary Statistics for Chemical Concentrations in Waste Material Groundwater Samples Collected from
Soil Investigation Area 4 (Southern Impoundment)

Analyte	Number of Samples	Number of Detected Measurements	Detection Frequency	Detected Data		All Data
				Minimum	Maximum	Mean
Dioxin and Furans (pg/L)						
2,3,7,8-Tetrachlorodibenzo-p-dioxin	3	2	67%	8.92	32.4	20.7
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	3	0	0%			
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	3	0	0%			
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	3	1	33%	3.16	3.16	3.16
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	3	0	0%			
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	3	2	67%	22.1	56.2	39.1
2,3,7,8-Tetrachlorodibenzofuran	3	3	100%	29.3	110	66
1,2,3,7,8-Pentachlorodibenzofuran	3	2	67%	2.4	2.73	2.56
2,3,4,7,8-Pentachlorodibenzofuran	3	1	33%	2.02	2.02	2.02
1,2,3,4,7,8-Hexachlorodibenzofuran	3	3	100%	1.62	5.69	3.46
1,2,3,6,7,8-Hexachlorodibenzofuran	3	1	33%	0.61	0.61	0.61
1,2,3,7,8,9-Hexachlorodibenzofuran	3	0	0%			
2,3,4,6,7,8-Hexachlorodibenzofuran	3	0	0%			
1,2,3,4,6,7,8-Heptachlorodibenzofuran	3	1	33%	26.5	26.5	26.5
1,2,3,4,7,8,9-Heptachlorodibenzofuran	3	1	33%	3.47	3.47	3.47
TEQ _{DF,M} (ND=DL)	3	3	100%	14.4	48	30
TEQ _{DF,M} (ND=1/2DL)	3	3	100%	13.6	47.3	26
TEQ _{DF,M} (ND=0)	3	3	100%	6.42	46.7	22
Total Metals (mg/L)						
Aluminum	3	3	100%	0.0245	1.22	0.48
Arsenic	3	2	67%	0.00305	0.0105	0.0068
Barium	3	3	100%	0.245	0.256	0.25
Cadmium	3	0	0%			
Chromium	3	3	100%	0.0015	0.00298	0.00226
Cobalt	3	3	100%	0.00152	0.00465	0.00308
Copper	3	2	67%	0.00355	0.0087	0.00613
Lead	3	2	67%	0.00315	0.00933	0.00624
Magnesium	3	3	100%	41.4	184	134
Manganese	3	3	100%	2.04	2.29	2.18
Mercury	3	1	33%	4.00x10 ⁻⁵	4.00x10 ⁻⁵	4.00x10 ⁻⁵
Nickel	3	1	33%	0.00135	0.00135	0.00135
Thallium	3	3	100%	5.40x10 ⁻⁵	6.60x10 ⁻⁵	5.85x10 ⁻⁵
Vanadium	3	3	100%	0.00583	0.0071	0.00668
Zinc	3	3	100%	0.0016	0.0153	0.0098

Table 15
Summary Statistics for Chemical Concentrations in Groundwater Samples Collected from
Soil Investigation Area 4 (Southern Impoundment)

Analyte	Number of Samples	Number of Detected Measurements	Detection Frequency	Detected Data		All Data
				Minimum	Maximum	Mean
Dissolved Metals (mg/L)						
Aluminum	3	3	100%	0.011	0.609	0.214
Arsenic	3	1	33%	0.0094	0.0094	0.0094
Barium	3	3	100%	0.243	0.782	0.6
Cadmium	3	0	0%			
Chromium	3	1	33%	0.0007	0.0007	0.0007
Cobalt	3	3	100%	0.00156	0.005	0.00315
Copper	3	1	33%	0.0011	0.0011	0.0011
Lead	3	1	33%	0.0068	0.0068	0.0068
Magnesium	3	3	100%	42	85.3	70
Manganese	3	3	100%	2.07	2.26	2.19
Mercury	3	0	0%			
Nickel	3	3	100%	0.001	0.0035	0.00247
Thallium	3	1	33%	5.20x10 ⁻⁵	5.20x10 ⁻⁵	5.20x10 ⁻⁵
Vanadium	3	3	100%	0.00385	0.0094	0.00722
Zinc	3	3	100%	0.0029	0.0075	0.00467
Polycyclic Aromatic Hydrocarbons (µg/L)						
2-Methylnaphthalene	3	1	33%	0.1	0.1	0.1
2-Nitroaniline	3	0	0%			
3-Nitroaniline	3	0	0%			
4-Nitroaniline	3	0	0%			
Acenaphthene	3	2	67%	0.089	0.35	0.22
Acenaphthylene	3	2	67%	0.0175	0.021	0.0192
Anthracene	3	3	100%	0.16	0.255	0.202
Benzo[a]anthracene	3	0	0%			
Benzo[a]pyrene	3	0	0%			
Benzo[b]fluoranthene	3	0	0%			
Benzo[g,h,i]perylene	3	0	0%			
Benzo[k]fluoranthene	3	0	0%			
Chrysene	3	1	33%	0.0235	0.0235	0.0235
Dibenzofuran	3	0	0%			
Dibenzo[a,h]anthracene	3	0	0%			
Fluoranthene	3	2	67%	0.028	0.11	0.069
Fluorene	3	2	67%	0.042	0.074	0.058
Indeno[1,2,3-cd]pyrene	3	0	0%			

Table 15
Summary Statistics for Chemical Concentrations in Groundwater Samples Collected from
Soil Investigation Area 4 (Southern Impoundment)

Analyte	Number of Samples	Number of Detected Measurements	Detection Frequency	Detected Data		All Data
				Minimum	Maximum	Mean
Naphthalene	3	0	0%			
Phenanthrene	3	3	100%	0.0252	0.069	0.0418
Pyrene	3	2	67%	0.0325	0.12	0.076
Polychlorinated Biphenyls (µg/L)						
Aroclor 1016	3	0	0%			
Aroclor 1221	3	0	0%			
Aroclor 1232	3	0	0%			
Aroclor 1242	3	0	0%			
Aroclor 1248	3	0	0%			
Aroclor 1254	3	1	33%	0.086	0.086	0.086
Aroclor 1260	3	2	67%	0.00545	0.037	0.0212
Aroclor 1262	3	0	0%			
Aroclor 1268	3	0	0%			
Pesticides (µg/L)						
Carbazole	3	2	67%	0.0242	0.059	0.0416
Phenols (µg/L)						
2,4,5-Trichlorophenol	3	0	0%			
2,4,6-Trichlorophenol	3	0	0%			
2,4-Dichlorophenol	3	0	0%			
2-Chlorophenol	3	0	0%			
Pentachlorophenol	3	0	0%			
Conventional Chemistry (mg/L)						
Total Dissolved Solids	3	3	100%	1,520	5,040	3,100
Total Suspended Solids	3	3	100%	22	77.5	54.2
Semivolatile Organic Compounds (µg/L)						
1,2,4-Trichlorobenzene	3	0	0%			
1,2-Dichlorobenzene	3	0	0%			
1,3-Dichlorobenzene	3	1	33%	0.86	0.86	0.86
1,4-Dichlorobenzene	3	0	0%			
2,2'-oxybis(1-Chloropropane)	3	0	0%			
2,4-Dimethylphenol	3	0	0%			
2,4-Dinitrophenol	3	0	0%			
2,4-Dinitrotoluene	3	0	0%			
2,6-Dinitrotoluene	3	0	0%			
2-Chloronaphthalene	3	0	0%			
2-Methylphenol	3	0	0%			
2-Nitrophenol	3	0	0%			

Table 15
Summary Statistics for Chemical Concentrations in Groundwater Samples Collected from Soil Investigation Area 4

Analyte	Number of Samples	Number of Detected Measurements	Detection Frequency	Detected Data		All Data
				Minimum	Maximum	Mean
3,3'-Dichlorobenzidine	3	0	0%			
4,6-Dinitro-2-methylphenol	3	0	0%			
4-Bromophenyl-phenylether	3	0	0%			
4-Chloro-3-methylphenol	3	0	0%			
4-Chloroaniline	3	0	0%			
4-Chlorophenyl-phenyl ether	3	0	0%			
4-Methylphenol	3	1	33%	1.3	1.3	1.3
4-Nitrophenol	3	0	0%			
Benzoic acid	3	3	100%	2.65	7	4.65
Benzyl alcohol	3	2	67%	0.0587	0.37	0.214
Bis(2-chloroethyl)ether	3	0	0%			
bis(2-Chloroethoxy)methane	3	0	0%			
bis(2-Ethylhexyl)phthalate	3	1	33%	0.2	0.2	0.2
Benzyl n-butyl phthalate	3	0	0%			
Diethyl phthalate	3	0	0%			
Dimethyl phthalate	3	1	33%	0.019	0.019	0.019
Di-n-butyl phthalate	3	0	0%			
Di-n-octylphthalate	3	0	0%			
Hexachloroethane	3	0	0%			
Hexachlorobenzene	3	0	0%			
Hexachlorobutadiene	3	0	0%			
Hexachlorocyclopentadiene	3	0	0%			
Isophorone	3	0	0%			
Nitrobenzene	3	0	0%			
N-Nitrosodi-n-propylamine	3	0	0%			
N-Nitrosodiphenylamine	3	2	67%	0.14	0.43	0.285
Phenol	3	3	100%	0.08	0.24	0.145
Volatile Organic Compounds (µg/L)						
1,1,1,2-Tetrachloroethane	3	0	0%			
1,1,1-Trichloroethane	3	0	0%			
1,1,2,2-Tetrachloroethane	3	1	33%	0.51	0.51	0.51
1,1,2-Trichloroethane	3	0	0%			
1,1-Dichloroethane	3	0	0%			
1,1-Dichloroethene	3	0	0%			
1,1-Dichloropropene	3	0	0%			
1,2,3-Trichlorobenzene	3	0	0%			
1,2,3-Trichloropropane	3	0	0%			

Table 15
Summary Statistics for Chemical Concentrations in Groundwater Samples Collected from
Soil Investigation Area 4 (Southern Impoundment)

Analyte	Number of Samples	Number of Detected Measurements	Detection Frequency	Detected Data		All Data
				Minimum	Maximum	Mean
1,2,4-Trimethylbenzene	3	2	67%	0.11	0.33	0.22
1,2-Dibromo-3-chloropropane	3	0	0%			
1,2-Dibromoethane	3	0	0%			
1,2-Dichloroethane	3	0	0%			
1,2-Dichloropropane	3	0	0%			
1,3,5-Trimethylbenzene	3	1	33%	0.12	0.12	0.12
1,3-Dichloropropane	3	0	0%			
2,2-Dichloropropane	3	0	0%			
2-Chlorotoluene	3	0	0%			
2-Hexanone	3	0	0%			
4-Chlorotoluene	3	0	0%			
4-Isopropyl toluene	3	1	33%	0.26	0.26	0.26
4-Methyl-2-pentanone	3	0	0%			
Acetone	3	2	67%	3.8	17	10.4
Benzene	3	3	100%	0.07	5	1.73
Bromobenzene	3	0	0%			
Bromochloromethane	3	1	33%	0.23	0.23	0.23
Bromodichloromethane	3	3	100%	0.1	0.85	0.4
Bromomethane	3	0	0%			
Bromoform	3	2	67%	0.32	1	0.66
Sum of benzene, toluene, ethylbenzene, and xylenes (ND = 0)	3	3	100%	0.12	17.3	5.9
Carbon disulfide	3	3	100%	0.0522	0.53	0.274
Carbon Tetrachloride	3	0	0%			
Chloroform	3	3	100%	0.09	0.52	0.252
cis-1,2-Dichloroethene	3	0	0%			
cis-1,3-Dichloropropene	3	0	0%			
Chlorobenzene	3	1	33%	0.23	0.23	0.23
Chloroethane	3	0	0%			
Chloromethane	3	0	0%			
Dibromochloromethane	3	2	67%	0.38	1.5	0.94
Dibromomethane	3	1	33%	0.2	0.2	0.2
Dichlorodifluoromethane	3	0	0%			
Ethylbenzene	3	1	33%	2.3	2.3	2.3
Isopropylbenzene	3	2	67%	0.09	0.1	0.09
2-Butanone	3	1	33%	3.1	3.1	3.1
m,p-Xylene	3	2	67%	0.13	6.6	3.36
Methylene Chloride	3	0	0%			

Table 15
Summary Statistics for Chemical Concentrations in Groundwater Samples Collected from
Soil Investigation Area 4 (Southern Impoundment)

Analyte	Number of Samples	Number of Detected Measurements	Detection Frequency	Detected Data		All Data
				Minimum	Maximum	Mean
n-Butylbenzene	3	2	67%	0.0535	0.13	0.092
n-Propylbenzene	3	2	67%	0.07	0.3	0.185
o-Xylene	3	1	33%	3.4	3.4	3.4
sec-Butylbenzene	3	0	0%			
Styrene	3	0	0%			
tert-Butylbenzene	3	0	0%			
Tetrachloroethene	3	0	0%			
Toluene	3	0	0%			
Sum of chlorinated Volatile Organic Compounds (ND = 0)	3	3	100%	0.35	4.85	2.2
Trichloroethene	3	3	100%	0.15	0.645	0.318
trans-1,2-Dichloroethene	3	0	0%			
trans-1,3-Dichloropropene	3	0	0%			
Trichlorofluoromethane	3	0	0%			
Vinyl Chloride	3	0	0%			

Notes

DL = detection limit

ND = nondetect

TEF = toxicity equivalence factor

TEQ_{DF,M} = Toxicity equivalent for dioxins and furans calculated using mammalian toxicity equivalency factors (Van den Berg et al. 2006).

Modified from: Integral Consulting Inc. and Anchor QEA, LLC. 2013. Remedial Investigation Report, San Jacinto River Waste Pits Superfund Site.
Prepared for: McGinnes Industrial Maintenance Corporation, International Paper Company, and U.S. Environmental Protection Agency, Region 6. May.

Table 16

Baseline Human Health Risk Assessment Exposure Parameters for Deterministic Evaluation for the Area North of I-10 and Aquatic Environment

	Abbreviation	Units	Hypothetical Recreational Fisher				Hypothetical Subsistence Fisher			Hypothetical Recreational Visitor			
			RME			CTE	RME			RME			CTE
			Adult	Older Child	Young Child	Adult	Adult	Older Child	Young Child	Adult	Older Child	Young Child	Adult
All Pathways													
Body weight	BW	kg	80	50	19	80	80	50	19	80	50	19	80
Exposure duration	ED	years	16	11	6	12	16	11	6	16	11	6	12
Averaging time - non-carcinogens	ATn	days	5,840	4,015	2,190	4,380	5,840	4,015	2,190	5,840	4,015	2,190	4,380
Averaging time - carcinogens	ATc	days	28,470	28,470	28,470	28,470	28,470	28,470	28,470	28,470	28,470	28,470	28,470
Ingestion of Fish and Shellfish													
Exposure frequency, fish, shellfish	EF _{fish-shellfish}	days/year	365	365	365	365	365	365	365	--	--	--	--
Ingestion rate, fish	IR _{fish}	g/day	24	18	14	21	58	45	30	--	--	--	--
Ingestion rate, shellfish	IR _{shellfish}	g/day	1.4	1.0	0.6	1.0	3.8	4.5	2.0	--	--	--	--
Fraction of total fish or shellfish intake that is site-related	FI _{fish-shellfish}	% as fraction	0.25	0.25	0.25	0.10	1	1	1	--	--	--	--
Ingestion of Soil and Sediment													
Exposure frequency; soil, sediment	EF _{soil-sed}	days/year	39	39	39	13	104	104	104	104	104	104	52
Ingestion rate, soil	IR _{soil}	mg/day	20	50	125	20	20	50	125	20	50	125	20
Ingestion rate, sediment	IR _{sed}	mg/day	20	50	125	20	20	50	125	20	50	125	20
Fraction of total ingestion that is soil	F _{soil}	% as fraction	0	0	0	0	0	0	0	0.5	0.5	0.5	0.5
Fraction of total ingestion that is sediment	F _{sed}	% as fraction	1	1	1	1	1	1	1	0.5	0.5	0.5	0.5
Fraction of total daily soil/sediment intake that is site-related	FI _{soil-sed}	% as fraction	1	1	1	0.5	1	1	1	1	1	1	0.5
Dermal Contact with Soil and Sediment													
Exposure frequency; soil, sediment	EF _{soil-sed}	days/year	39	39	39	13	104	104	104	104	104	104	52
Skin surface area	SA	cm ²	6,080	4,270	3,280	6,080	6,080	4,270	3,280	6,080	4,270	3,280	6,080
Adherence factor, soil	AF _{soil}	mg/cm ²	0.07	0.07	0.09	0.07	0.07	0.07	0.09	0.07	0.07	0.09	0.07
Adherence factor, sediment	AF _{sed}	mg/cm ²	4.9	5.1	3.6	4.9	4.9	5.1	3.6	4.9	5.1	3.6	4.9
Fraction of pathway exposure that is soil	F _{soil}	% as fraction	0	0	0	0	0	0	0	0.5	0.5	0.5	0.5
Fraction of pathway exposure that is sediment	F _{sed}	% as fraction	1	1	1	1	1	1	1	0.5	0.5	0.5	0.5
Fraction of total daily soil/sediment intake that is site-related	FI _{soil-sed}	% as fraction	1	1	1	0.5	1	1	1	1	1	1	0.5
Event frequency	EV	1/day	1	1	1	1	1	1	1	1	1	1	1

Notes

-- = Not applicable; pathway is not evaluated for receptor.

CTE = central tendency exposure

RME = reasonable maximum exposure

ABS_d = dermal absorption factor for soil and sediment

COPCH = chemical of potential concern for human health

LOSS = chemical reduction due to preparation and cooking

RBA_{tissue} = relative bioavailability adjustment for tissueRBA_{ss} = relative bioavailability adjustment for soil and sediment

COPCH	ABS _d (% as fraction)	RBA _{ss} (% as fraction)	RBA _{tissue} (% as fraction)	LOSS (% as fraction)
Dioxins and Furans				
Dioxins and Furans	0.03 ^a	0.5 ^b	1 ^c	0 ^c

a - Value is from USEPA (2004)

b - Multiple sources were used to derive this value

c - Conservative default assumption

d - Value is from CalEPA (2011)

Modified from: Integral Consulting Inc. and Anchor QEA, LLC. 2013. Baseline Human Health Risk Assessment, San Jacinto River Waste Pits Superfund Site.
 Prepared for: McGinnes Industrial Maintenance Corporation, International Paper Company, and U.S. Environmental Protection Agency, Region 6. May.

Table 17
Baseline Human Health Risk Assessment Exposure Scenarios for the Area North of I-10 and Aquatic Environment

Scenario	Exposure Unit			
	Sediment EU(s)	Soil EU(s)	Finfish EU(s)	Shellfish EU(s)
Northern Impoundments and Aquatic Environment				
Hypothetical Fisher (Recreational and Subsistence)				
Scenario 1A	Beach Area A	--	Hardhead Catfish: FCA 2/3	--
Scenario 1B	Beach Area A	--	--	Clam: FCA 1/3
Scenario 1C	Beach Area A	--	--	Crab: FCA 2/3
Scenario 2A	Beach Area B/C	--	Hardhead Catfish: FCA 2/3	--
Scenario 2B	Beach Area B/C	--	--	Clam: 2
Scenario 2C	Beach Area B/C	--	--	Crab: FCA 2/3
Scenario 3A	Beach Area E	--	Hardhead Catfish: FCA 2/3	--
Scenario 3B	Beach Area E	--	--	Clam: 2
Scenario 3C	Beach Area E	--	--	Crab: FCA 2/3
Scenario 4A	Beach Area D	--	Hardhead Catfish: FCA 1	--
Scenario 4B	Beach Area D	--	--	Clam: FCA 1/3
Scenario 4C	Beach Area D	--	--	Crab: FCA 1
Hypothetical Recreational Visitor				
Scenario 1	Beach Area A	Soils North of I-10	--	--
Scenario 2	Beach Area B/C	Soils North of I-10	--	--
Scenario 3	Beach Area E	Soils North of I-10	--	--
Scenario 4	Beach Area D	Soils North of I-10	--	--
Area of Investigation on the Peninsula South of I-10				
Hypothetical Trespasser				
Scenario 1	--	Area of Investigation on the Peninsula South of I-10	--	--
Hypothetical Commercial Worker				
Scenario 1	--	Area of Investigation on the Peninsula South of I-10	--	--
Hypothetical Construction Worker				
Scenario DS-1	--	DS-1	--	--
Scenario DS-2	--	DS-2	--	--
Scenario DS-3	--	DS-3	--	--
Scenario DS-4	--	DS-4	--	--
Scenario DS-5	--	DS-5	--	--

Notes

-- = Not applicable, see CSM and refined conceptualization of potential exposure pathways presented in Section 4 of the text.

BHHRA = baseline human health risk assessment

CSM = conceptual site model

DS = deep soil

EU = exposure unit

FCA = fish collection area

Modified from: Integral Consulting Inc. and Anchor QEA, LLC. 2013. Baseline Human Health Risk Assessment, San Jacinto River Waste Pits Superfund Site. Prepared for: McGinnes Industrial Maintenance Corporation, International Paper Company, and U.S. Environmental Protection Agency, Region 6. May.

Table 18
Baseline Human Health Risk Assessment Exposure Parameters for Deterministic Evaluation for the Area South of I-10

		Units	Hypothetical Trespasser		Hypothetical Commercial Worker		Hypothetical Construction Worker	
			RME	CTE	RME	CTE	RME	CTE
All Pathways								
Body weight	BW	kg	74	74	80	80	80	80
Exposure duration	ED	years	7	4	25	12	1	1
Fraction of total daily soil intake that is site-related	FI _{soil}	% as fraction	0.5	0.25	1	1	1	1
Exposure frequency, soil	EF _{soil}	days/year	24	12	225	225	250	125
Averaging time - non-carcinogens	ATn	days	2,555	1,460	9,125	4,380	365	365
Averaging time - carcinogens	ATc	days	28,470	28,470	28,470	28,470	28,470	28,470
Ingestion of Soil								
Ingestion rate, soil	IR _{soil}	mg/day	41	41	100	50	330	100
Dermal Contact with Soil								
Skin surface area	SA	cm ²	5,550	5,550	3,470	3,470	2,630	2,630
Adherence factor, soil	AF _{soil}	mg/cm ²	0.07	0.07	0.2	0.2	0.2	0.2
Event frequency	EV	1/day	1	1	1	1	1	1

Notes

CTE = central tendency exposure

RME = reasonable maximum exposure

ABS_d = dermal absorption factor for soil and sediment

COPCH = chemical of potential concern for human health

LOSS = chemical reduction due to preparation and cooking

RBA_{tissue} = relative bioavailability adjustment for tissue

RBA_{ss} = relative bioavailability adjustment for soil and sediment

COPC _H	ABS _d (% as fraction)	RBA _{ss} (% as fraction)	RBA _{tissue} (% as fraction)	LOSS (% as fraction)
Dioxins and Furans				
Dioxins and Furans	0.03 ^a	0.5 ^b	1 ^c	0 ^c

a - Value is from USEPA (2004)

b - Multiple sources were used to derive this value

c - Conservative default assumption

d - Value is from CalEPA (2011)

Modified from: Integral Consulting Inc. and Anchor QEA, LLC. 2013. Baseline Human Health Risk Assessment, San Jacinto River Waste Pits Superfund Site.
 Prepared for: McGinnes Industrial Maintenance Corporation, International Paper Company, and U.S. Environmental Protection Agency, Region 6. May.

Table 19
Chemicals of Potential Ecological Concern Screening for Benthic Macroinvertebrate Community, North of I-10

Chemical	NOEC ^a	Highest Site Concentration (TCEQ and USEPA 2006) ^b	Frequency of Detection of Site Samples	Does Maximum Site Sample Exceed NOEC?	Maintain as COPC for Benthic Invertebrates?	Reason for COPC Decision
Metals (mg/kg)						
Aluminum	NV	22,100	7/7	NSLV	Yes	No SLV, detected at least once in Site sediments
Antimony	NV	7.2 <i>U</i>	1/7	NSLV	No	No SLV; however, there is only a single detection in Site data and this is not a chemical expected to be associated with pulp mill waste
Arsenic	8.2	3	4/7	No	No	Maximum site concentration does not exceed SLV
Barium	NV	244	7/7	NSLV	Yes	No SLV, detected at least once in Site sediments
Cadmium	1.2	0.7 <i>U</i>	4/7	No	No	Maximum site concentration does not exceed SLV
Chromium	81	22.1	7/7	No	No	Maximum site concentration does not exceed SLV
Cobalt	NV	6.8 <i>J</i>	7/7	NSLV	Yes	No SLV, detected at least once in Site sediments
Copper	34	62.5	7/7	Yes	Yes	Maximum site concentration exceeds SLV
Lead	46.7	59.3	7/7	No	Yes	Maximum site concentration exceeds SLV
Magnesium	NV	4,790	7/7	NSLV	Yes	No screening value, detected at least once in Site sediments
Manganese	NV	790	7/7	NSLV	Yes	No screening value, detected at least once in Site sediments
Mercury	0.15	1.7	7/7	Yes	Yes	Maximum site concentration exceeds SLV
Nickel	20.9	14	7/7	No	No	Maximum site concentration does not exceed SLV

Modified from: Integral Consulting Inc. 2013. Baseline Ecological Risk Assessment, San Jacinto River Waste Pits Superfund Site. Prepared for: McGinnes Industrial Maintenance Corporation, International Paper Company, and U.S. Environmental Protection Agency, Region 6. May.

Table 19
Chemicals of Potential Ecological Concern Screening for Benthic Macroinvertebrate Community, North of I-10

Chemical	NOEC ^a	Highest Site Concentration (TCEQ and USEPA 2006) ^b	Frequency of Detection of Site Samples	Does Maximum Site Sample Exceed NOEC?	Maintain as COPC for Benthic Invertebrates?	Reason for COPC Decision
Silver	1	1.4 <i>U</i>	2/7	Yes	No	Highest concentration is close to SLV. High percentage of non-detects. Highest detected concentration is 0.29, below SLV
Thallium	NV	3.5 <i>U</i>	0/7	NSLV	Yes (secondary)	No SLV, no detected concentrations in Site sediments
Vanadium	NV	34.4	7/7	NSLV	Yes	No SLV, detected at least once in Site sediments
Zinc	150	244	7/7	Yes	Yes	Maximum site concentration exceeds SLV
Dioxins/Furans (ng/kg)						
2,3,7,8-TCDD	25,000 ^c	18,500	7/7	No	No ^d	Maximum site value does not exceed SLV
Polychlorinated Biphenyls (PCBs) (µg/kg)						
Total PCBs	1,200 ^e	90 <i>U</i> ^f	0/7	N/A	No	Highest detection limit does not exceed screening value
Semivolatile Organic Compounds (µg/kg)						
Acenaphthene	16	455 <i>U</i>	0/7	Yes	Yes (secondary)	No SLV, no detected concentrations in Site sediments
Fluorene	19	455 <i>U</i>	0/7	Yes	Yes (secondary)	No SLV, no detected concentrations in Site sediments
Naphthalene	160	455 <i>U</i>	0/7	Yes	Yes (secondary)	No SLV, no detected concentrations in Site sediments
Phenanthrene	240	455 <i>U</i>	0/7	Yes	Yes (secondary)	No SLV, no detected concentrations in Site sediments

Modified from: Integral Consulting Inc. 2013. Baseline Ecological Risk Assessment, San Jacinto River Waste Pits Superfund Site. Prepared for: McGinnes Industrial Maintenance Corporation, International Paper Company, and U.S. Environmental Protection Agency, Region 6. May.

Table 19
Chemicals of Potential Ecological Concern Screening for Benthic Macroinvertebrate Community, North of I-10

Chemical	NOEC ^a	Highest Site Concentration (TCEQ and USEPA 2006) ^b	Frequency of Detection of Site Samples	Does Maximum Site Sample Exceed NOEC?	Maintain as COPC for Benthic Invertebrates?	Reason for COPC Decision
2,4,6-Trichlorophenol	NV	455 U	0/7	NSLV	Yes (secondary)	No SLV, no detected concentrations in Site sediments
2,4-Dichlorophenol	NV	455 U	0/7	NSLV	Yes (secondary)	No SLV, no detected concentrations in Site sediments
Pentachlorophenol	NV	1,150 U	0/7	NSLV	Yes (secondary)	No SLV, no detected concentrations in Site sediments
Phenol	NV	455 U	0/7	NSLV	Yes (secondary)	No SLV, no detected concentrations in Site sediments
Hexachlorobenzene	NV	455 U	0/7	NSLV	Yes (secondary)	No SLV, no detected concentrations in Site sediments
2,3,4,6-Tetrachlorophenol	NV	NV	NV	NA	Yes (secondary)	No information available on which to base evaluation
Carbazole	NV	455 U	0/7	NSLV	Yes (secondary)	No SLV, no detected concentrations
2,4,5-Trichlorophenol	NV	1,150 U	0/7	NSLV	Yes (secondary)	No SLV, no detected concentrations
Bis(2-ethylhexyl)phthalate	182	1800	3/7	Yes	Yes	Maximum site concentration exceeds SLV
Volatile Organic Compounds (µg/kg)						
Chloroform	4300 ^g	NV	NV	NA	Yes (secondary)	No information available on which to base evaluation
1,2,4-Trichlorobenzene	390	NV	NV	NA	Yes (secondary)	No information available on which to base evaluation
1,2-Dichlorobenzene	740	NV	NV	NA	Yes (secondary)	No information available on which to base evaluation

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Table 19
Chemicals of Potential Ecological Concern Screening for Benthic Macroinvertebrate Community, North of I-10

Chemical	NOEC ^a	Highest Site Concentration (TCEQ and USEPA 2006) ^b	Frequency of Detection of Site Samples	Does Maximum Site Sample Exceed NOEC?	Maintain as COPC for Benthic Invertebrates?	Reason for COPC Decision
1,3-Dichlorobenzene	320	NV	NV	NA	Yes (secondary)	No information available on which to base evaluation
1,4-Dichlorobenzene	700	NV	NV	NA	Yes (secondary)	No information available on which to base evaluation
1,2,3-Trichlorobenzene	NV	NV	NV	NA	Yes (secondary)	No information available on which to base evaluation

Notes

DL = detection limit

EqP = equilibrium partitioning

OC = organic carbon

NA = not applicable

NOEC = no effect concentration

a - NOEC (no effect concentration) is from TCEQ 2006 and is based on Long et al. (1995) unless otherwise indicated. Units of screening value match those of sediment data as given in compound class header (e.g., metals in mg/kg).

b - Nondetects are provided at 1/2 the detection limit.

c - Barber et al. (1998)

d - Although dioxins and furans passed the screening step, on the basis of information provided in Attachment B2, evaluation of risks to benthic invertebrates resulting from exposure to 2,3,7,8-TCDD is appropriate (Table B-6).

e - Fuchsman et al. (2006). Lowest unbounded NOEC (growth) for a PCB mixture of 81 mg/kg OC (*Macoma nasuta*). Using EqP and conservative estimate of organic carbon of 1.5 percent (Louchouart and Brinkmeyer 2009), the dry weight equivalent of this value is 1.2 mg/kg.

f - As there were no detections of PCBs, this value is the highest reporting limit in the data set for any of the Aroclors evaluated.

g - Table 3-3 in TCEQ (2006)

NV = no value

NSLV = no screening level value available

SLV = screening level value

J = estimated

U = analyte not detected

Table 20
Chemicals of Potential Ecological Concern Screening for Fish and Wildlife, North of I-10

Chemical	Highest Site Concentration (TCEQ and USEPA 2006) ^a	Frequency of Detection of Site Samples	Log Kow of Chemical (Organics Only) ^b	Is Chemical Potentially Bioaccumulative from Sediment? ^c	Maintain as COPC for Fish and Wildlife	Reason for COPC Decision
Metals (mg/kg)						
Aluminum	22,100	7/7	NA	No	No	Not potentially bioaccumulative
Antimony	7.2 <i>U</i>	1/7	NA	No	No	Not potentially bioaccumulative
Arsenic	3	7/7	NA	No	No	Not potentially bioaccumulative
Barium	244	7/7	NA	No	No	Not potentially bioaccumulative
Cadmium	0.7 <i>U</i>	4/7	NA	Yes	Yes	Potentially bioaccumulative,
Chromium	22.1	7/7	NA	No	No	Not potentially bioaccumulative
Cobalt	6.8 <i>J</i>	7/7	NA	No	No	Not potentially bioaccumulative
Copper	62.5	7/7	NA	Yes	Yes	Potentially bioaccumulative, detected at least once in Site sediments
Lead	59.3	7/7	NA	No	No	Not potentially bioaccumulative
Magnesium	4,790	7/7	NA	No	No	Not potentially bioaccumulative
Manganese	790	7/7	NA	No	No	Not potentially bioaccumulative
Mercury	1.7	7/7	NA	Yes	Yes	Potentially bioaccumulative, detected at least once in Site sediments
Nickel	14	7/7	NA	Yes	Yes	Potentially bioaccumulative, detected at least once in Site sediments

Table 20
Chemicals of Potential Ecological Concern Screening for Fish and Wildlife, North of I-10

Chemical	Highest Site Concentration (TCEQ and USEPA 2006) ^a	Frequency of Detection of Site Samples	Log Kow of Chemical (Organics Only) ^b	Is Chemical Potentially Bioaccumulative from Sediment? ^c	Maintain as COPC for Fish and Wildlife	Reason for COPC Decision
Silver	1.4 U	2/7	NA	No	No	Not potentially bioaccumulative
Thallium	3.5 U	0/7	NA	No	No	Not potentially bioaccumulative
Vanadium	34.4	7/7	NA	No	No	Not potentially bioaccumulative
Zinc	244	7/7	NA	Yes	Yes	Potentially bioaccumulative, detected at least once in Site sediments
Dioxins/Furans (ng/kg)						
TEQ birds at ND=1/2DL	62,200	N/A	>5	Yes	Yes	Potentially bioaccumulative, detected at least once in Site sediments
TEQ fish at ND=1/2DL	22,300	N/A	>5	Yes	Yes	Potentially bioaccumulative, detected at least once in Site sediments
TEQ mammals at ND=1/2 DL	24,000	N/A	>5	Yes	Yes	Potentially bioaccumulative, detected at least once in Site sediments
Polychlorinated Biphenyls (µg/kg)						
Total PCBs	90 U ^d	0/7	>5	Yes	Yes (secondary)	Potentially bioaccumulative, no detected concentrations in Site sediments
Semivolatile Organic Compounds (µg/kg)						
Acenaphthene	455 U	0/7	3.92	No ^e	No	Not potentially bioaccumulative

Table 20
Chemicals of Potential Ecological Concern Screening for Fish and Wildlife, North of I-10

Chemical	Highest Site Concentration (TCEQ and USEPA 2006) ^a	Frequency of Detection of Site Samples	Log Kow of Chemical (Organics Only) ^b	Is Chemical Potentially Bioaccumulative from Sediment? ^c	Maintain as COPC for Fish and Wildlife	Reason for COPC Decision
Fluorene	455 <i>U</i>	0/7	4.18	No ^e	No	Not potentially bioaccumulative
Naphthalene	455 <i>U</i>	0/7	3.3	No ^e	No	Not potentially bioaccumulative
Phenanthrene	455 <i>U</i>	0/7	4.57	No ^e	No	Not potentially bioaccumulative
2,4,6-Trichlorophenol	455 <i>U</i>	0/7	3.72	No ^e	No	Not potentially bioaccumulative
2,4-Dichlorophenol	455 <i>U</i>	0/7	3.06	No ^e	No	Not potentially bioaccumulative
Pentachlorophenol	1,150 <i>U</i>	0/7	5.12	Yes	Yes (secondary)	Potentially bioaccumulative, no detected concentrations in Site sediments
Phenol	455 <i>U</i>	0/7	1.46	No ^f	No	Not potentially bioaccumulative
Hexachlorobenzene	455 <i>U</i>	0/7	5.73	Yes	Yes (secondary)	Potentially bioaccumulative, no detected concentrations in Site sediments
2,3,4,6-Tetrachlorophenol	NV	NV	4.45	No ^e	No	Not potentially bioaccumulative
Carbazole	455 <i>U</i>	0/7	3.72	No ^e	No	Not potentially bioaccumulative
2,4,5-Trichlorophenol	1,150 <i>U</i>	0/7	3.69	No ^e	No	Not potentially bioaccumulative
Bis(2-ethylhexyl)phthalate	1800	3/7	7.6	Yes	Yes	Potentially bioaccumulative, detected in Site sediments

Table 20
Chemicals of Potential Ecological Concern Screening for Fish and Wildlife, North of I-10

Chemical	Highest Site Concentration (TCEQ and USEPA 2006) ^a	Frequency of Detection of Site Samples	Log Kow of Chemical (Organics Only) ^b	Is Chemical Potentially Bioaccumulative from Sediment? ^c	Maintain as COPC for Fish and Wildlife	Reason for COPC Decision
Volatile Organic Compounds (µg/kg)						
Chloroform	NV	NV	1.97	No ^e	No	Not potentially bioaccumulative
1,2,4-Trichlorobenzene	NV	NV	4.02	No ^e	No	Not potentially bioaccumulative
1,2-Dichlorobenzene	NV	NV	3.43	No ^e	No	Not potentially bioaccumulative
1,3-Dichlorobenzene	NV	NV	3.53	No ^e	No	Not potentially bioaccumulative
1,4-Dichlorobenzene	NV	NV	3.44	No ^e	No	Not potentially bioaccumulative
1,2,3-Trichlorobenzene	NV	NV	4.05	No ^e	No	Not potentially bioaccumulative

Notes

COPC = chemical of potential concern

NA = not applicable

NV = no value

TCEQ = Texas Commission on Environmental Quality

TEQ = toxicity equivalent

J = estimated

U = analyte not detected

a - Undetected values are set to 1/2 the detection limit.

b - Log Kow: Octanol-water partition coefficient, the ratio of the concentration of a chemical in octanol and water at equilibrium and at a specified temperature.

Octanol is an organic solvent that is used as a surrogate for natural organic matter (e.g.,

c - Determination of bioaccumulative potential is based on TCEQ guidance (TCEQ 2006) or, if chemical is not addressed in guidance, log Kow information is used to determine bioaccumulative potential (as indicated in footnote e), with those chemicals having

d - As there were no detections of PCBs, this value is the highest reporting limit in the dataset for PCBs+A66

e - Not provided in TCEQ guidance; log Kow used to determine potential for bioaccumulation as described in footnote d.

Table 21
Ecological Screening Results for Surface and Shallow Subsurface Soils for the Area South of I-10

Chemical of Interest	Maximum Detected Concentration, Surface and Shallow Subsurface Soils (0 to 6 and 6 to 12 inch)	Ecological Screening Value, Mammals ^a	Maximum Exceeds Screening Value	Ecological Screening Value, Birds ^a	Maximum Exceeds Screening Value	Median for Background Soils (0 to 12 inch)	Maximum Exceeds Site-Specific Median Background
Metals (mg/kg - dw)							
Aluminum	11,700	30,000 ^b		30,000 ^b			
Antimony	1.00 J	0.27	X	1 ^b			
Arsenic	5.28 J	46		43			
Barium	413 J	2,000		300 ^b	X		
Cadmium	1.28	0.36	X	0.77	X		
Chromium	70.3 J	30 ^b	X	30 ^b	X		
Cobalt	22.1	230		120			
Copper	121 J	49	X	28	X		
Lead	117 J	56	X	11	X		
Magnesium	9,150	NA	--	NA	--	942	X
Manganese	2,630 J	4,000		4,300			
Mercury	0.156	0.04 ^b	X	0.04 ^b	X		
Nickel	85.1	130		210			
Silver	0.800 J	14		4.2			
Thallium	9.80 J	0.7 ^b	X	0.7 ^b	X		
Vanadium	52.1	280		7.8	X		
Zinc	4,160 J	79	X	46	X		
Polychlorinated Biphenyls (µg/kg-dw)							
Total PCBs	427	NA	--	NA	--	9.5	X
Semivolatile Organic Compounds (µg/kg-dw)							
1,2-Dichlorobenzene	0.055 U	NA	--	NA	--	0.048 ^c	X
1,3-Dichlorobenzene	0.07 U	NA	--	NA	--	0.06 ^c	X
1,4-Dichlorobenzene	0.06 U	NA	--	NA	--	0.055 ^c	X
Acenaphthene	88	NA	--	NA	--	0.7	X
Bis(2-ethylhexyl)phthalate	2,200	NA	--	NA	--	5.35	X
Carbazole	48	NA	--	NA	--	0.65	X
Fluorene	46	NA	--	NA	--	0.55	X
Naphthalene	50	NA	--	NA	--	1.15	X
Phenanthrene	450	NA	--	NA	--	2.4	X
Phenol	6.5 U	NA	--	NA	--	1.4 ^d	X

Notes

-- = uncertain; no screening value is available for this chemical

NA = no screening value available

U = not detected

X = maximum concentration exceeds screening value

a - USEPA's (2005) EcoSSLs were used, and where they were not available, Texas Median Background concentration is shown (Table E-5)

b - The Texas median background concentration is shown.

c - Analyte was never detected in 0- to 12-inch background soils; value shown is the median of the estimated values (i.e., one-half of detection limit) for the chemical in background samples from 0 to 6 inches.

d - Detected in 1 of 40 samples.

Modified from: Integral Consulting Inc. and Anchor QEA, LLC. 2013. Remedial Investigation Report, San Jacinto River Waste Pits Superfund Site.
Prepared for: McGinnes Industrial Maintenance Corporation, International Paper Company, and U.S. Environmental Protection Agency, Region 6. May.

Table 22
Selection of Chemicals of Potential Ecological Concern for the Southern Impoundment

Chemical	Log Kow of Chemical (Organics Only) ^a	Is Chemical Potentially Bioaccumulative? ^b	Maximum Exceeds Avian Screening Value or Background	Maximum Exceeds Mammalian Screening Value or Background	Maintain as COPC for South Impoundment Receptors?		Reason for COPC Decision
					Birds and Reptiles	Mammals	
Metals (mg/kg)							
Aluminum	NA	No	No	No	No	No	Not potentially bioaccumulative
Antimony	NA	No	No	Yes	No	No	Not potentially bioaccumulative
Arsenic	NA	No	No	No	No	No	Not potentially bioaccumulative, did not exceed EcoSSLs
Barium	NA	No	B	No	No	No	Not potentially bioaccumulative, did not exceed EcoSSL for mammals
Cadmium	NA	Yes	Yes	Yes	Yes	Yes	Potentially bioaccumulative, exceeds bird and mammal EcoSSLs
Chromium	NA	Yes	B	B	Yes	Yes	Potentially bioaccumulative, exceeds Texas Median Background
Cobalt	NA	No	No	No	No	No	Not potentially bioaccumulative, did not exceed EcoSSLs
Copper	NA	Yes	Yes	Yes	Yes	Yes	Potentially bioaccumulative, exceeds bird and mammal EcoSSLs
Lead	NA	Yes	Yes	Yes	Yes	Yes	Potentially bioaccumulative, exceeds bird and mammal EcoSSLs
Magnesium	NA	No	B	B	No	No	Not potentially bioaccumulative
Manganese	NA	No	No	No	No	No	Not potentially bioaccumulative, did not exceed EcoSSLs
Mercury	NA	Yes	B	B	Yes	Yes	Potentially bioaccumulative, exceeds Texas Median Background
Nickel	NA	Yes	No	No	No	No	Potentially bioaccumulative, but did not exceed mammal or bird EcoSSLs
Silver	NA	No	No	No	No	No	Not potentially bioaccumulative, did not exceed EcoSSLs
Thallium	NA	No	B	B	No	No	Not potentially bioaccumulative
Vanadium	NA	No	Yes	No	No	No	Not potentially bioaccumulative, did not exceed mammal EcoSSL
Zinc	NA	Yes	Yes	Yes	Yes	Yes	Potentially bioaccumulative, exceeds bird and mammal EcoSSLs
Dioxins/Furans (ng/kg)	>5	Yes	NA	NA	Yes	Yes	Potentially bioaccumulative, indicator chemical group
Polychlorinated Biphenyls (µg/kg)	>5	Yes	B	B	Yes	Yes	Potentially bioaccumulative, detected above background
Semivolatile Organic Compounds (µg/kg)							
2,4-Dichlorophenol	3.06	No ^c	NA	NA	No	No	Detected in less than 5% of samples, not potentially bioaccumulative
2,4,5-Trichlorophenol	3.69	No ^c	NA	NA	No	No	Detected in less than 5% of samples, not potentially bioaccumulative
2,4,6-Trichlorophenol	3.72	No ^c	NA	NA	No	No	Detected in less than 5% of samples, not potentially bioaccumulative
2,3,4,6-Tetrachlorophenol	4.45	No ^c	NA	NA	No	No	Detected in less than 5% of samples, not potentially bioaccumulative
Acenaphthene	3.92	No ^c	B	B	No	No	Not potentially bioaccumulative
Bis(2-ethylhexyl)phthalate	7.6	Yes	B	B	Yes	Yes	Potentially bioaccumulative, present above the Site-specific background median concentration
Carbazole	3.72	No ^c	B	B	No	No	Not potentially bioaccumulative
Fluorene	4.18	No ^c	B	B	No	No	Not potentially bioaccumulative
Hexachlorobenzene	5.73	Yes	NA	NA	No	No	Detected in less than 5% of samples
Naphthalene	3.3	No ^c	B	B	No	No	Not potentially bioaccumulative
Pentachlorophenol	5.12	Yes	NA	NA	No	No	Detected in less than 5% of samples
Phenanthrene	4.57	No ^c	B	B	No	No	Not potentially bioaccumulative
Phenol	1.46	No	B	B	No	No	Not potentially bioaccumulative

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 Prepared for: McGinnes Industrial Maintenance Corporation, International Paper Company, and U.S. Environmental Protection Agency, Region 6. May.

Table 22
Selection of Chemicals of Potential Ecological Concern for the Southern Impoundment

Chemical	Log Kow of Chemical (Organics Only) ^a	Is Chemical Potentially Bioaccumulative? ^b	Maximum Exceeds Avian Screening Value or Background	Maximum Exceeds Mammalian Screening Value or Background	Maintain as COPC for South Impoundment Receptors?		Reason for COPC Decision
					Birds and Reptiles	Mammals	
Volatile Organic Compounds (µg/kg)							
1,2-Dichlorobenzene	3.43	No ^c	B	B	No	No	Not potentially bioaccumulative, maximum concentration was non-detect
1,3-Dichlorobenzene	3.53	No ^c	B	B	No	No	Not potentially bioaccumulative, maximum concentration was non-detect
1,4-Dichlorobenzene	3.44	No ^c	B	B	No	No	Not potentially bioaccumulative, max.concentration was non-detect
1,2,3-Trichlorobenzene	4.05	No ^c	NA	NA	No	No	Detected in less than 5% of samples, not potentially bioaccumulative
1,2,4-Trichlorobenzene	4.02	No ^c	NA	NA	No	No	Detected in less than 5% of samples, not potentially bioaccumulative
Chloroform	1.97	No ^c	NA	NA	No	No	Detected in less than 5% of samples, not potentially bioaccumulative

Notes

B = Maximum concentration exceeds Texas median background concentration or Site-specific median background concentration

COPC_i = chemical of potential concern for south impoundment ecological receptors

NA = not applicable

TCEQ = Texas Commission on Environmental Quality

a - Log Kow: Octanol-water partition coefficient, the ratio of the concentration of a chemical in octanol and water at equilibrium and at a specified temperature. Octanol is an organic solvent that is used as a surrogate for natural organic matter (e.g., lipids). Values obtained from the HSDB (<http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB>) or Oak Ridge National Laboratory Risk Assessment Information System (http://rais.ornl.gov/cgi-bin/tox/TOX_select?select=chem)

b - Determination of potential for bioaccumulation from soil is based on TCEQ guidance (TCEQ 2006) or, if chemical is not addressed in guidance, log Kow information is used to determine bioaccumulative potential (as indicated in footnote c), with those chemicals having log Kow>5 being considered potentially bioaccumulative (USEPA 2008).

c - Not provided in TCEQ guidance; log Kow used to determine potential for bioaccumulation as described in footnote b.

Table 23
Summary of Ecological Receptor Surrogates for the Area North of I-10 and Aquatic Environment

Receptor Group	Receptor Surrogate	Feeding Guild	Potentially Present	Representative of One or More Feeding Guilds	High Site Fidelity/Residential	Sensitive or Potentially Highly Exposed	Life History Information Is Readily Available	Additional Considerations
Benthic macroinvertebrates								
	Benthic macroinvertebrate community	All	X	X	X	X	X	Close association with sediment; much of the toxicological literature addresses community level endpoints.
	Molluscs	Filter feeders	X	X	X	X ^a	X	Close association with sediment
Fish								
	Gulf killifish	Omnivore	X	X	X		X	Common prey for other fish and bird species
	Black drum	Benthic invertivore	X	X	X		X	Popular sport fish; limited range, limited interbay movement
	Southern flounder	Benthic piscivore	X	X	X ^b	X	X	Supports commercial and recreational fisheries
Reptiles								
	Alligator snapping turtle	Omnivore	X	X	X	X	X	Sensitive species (rare in estuaries)
Birds								
	Neotropic cormorant	Piscivore (diving)	X	X			X	
	Great blue heron	Piscivore (wading)	X	X			X	
	Spotted sandpiper	Invertivore (probing)	X	X		X	X	As a sediment-probing invertivore, expected to be closely associated with sediment exposure pathway
	Killdeer	Invertivore (terrestrial)	X	X	X		X	Feeds on invertebrate fauna closely associated with soils
Mammals								
	Marsh Rice Rat	Omnivore	X	X	X		X	Semi-aquatic, diet consists of aquatic and emergent plants, and invertebrates
	Raccoon	Omnivore	X	X			X	Representative of both aquatic and terrestrial omnivorous feeding guilds

Notes

- a - Sensitive reproductive endpoint
- b - Site fidelity is probably high except in winter, when this species moves into more saline waters to spawn.

Modified from: Integral Consulting Inc. 2013. Baseline Ecological Risk Assessment, San Jacinto River Waste Pits Superfund Site. Prepared for: McGinnes Industrial Maintenance Corporation, International Paper Company, and U.S. Environmental Protection Agency, Region 6. May.

Table 24
Summary of Ecological Receptor Surrogates for the Area South of I-10

Receptor Group	Receptor Surrogate	Feeding Guild	Potentially Present	Representative of One or More Feeding Guilds	High Site Fidelity/Residential	Sensitive or Potentially Highly Exposed	Life History Information Is Readily Available	Additional Considerations
Reptiles								
	Common garter snake	Carnivore	X	X	X	X	X	
Birds								
	Killdeer	Invertivore (terrestrial)	X	X	X		X	Feeds on invertebrate fauna closely associated with soils
Mammals								
	Pocket gopher	Herbivore	X	X	X	X	X	Burrowing mammal, used to evaluate both ingestion and inhalation pathways
	Virginia opossum	Omnivore	X	X	X		X	

Modified from: Integral Consulting Inc. and Anchor QEA, LLC. 2013. Remedial Investigation Report, San Jacinto River Waste Pits Superfund Site.
Prepared for: McGinnes Industrial Maintenance Corporation, International Paper Company, and U.S. Environmental Protection Agency, Region 6. May.

Table 25
Summary of Lines of Evidence for Ecological Receptors and Assessment Endpoints for the Area North of I-10 and Aquatic Environment

Receptor	Assessment Endpoint	Lines of Evidence	Measure of Exposure	Measure of Effect	Comments/Rationale
Benthic Macroinvertebrates	Abundance and diversity of benthic macroinvertebrate communities	Comparison of COPC _E concentrations in sediment to literature-based effects levels	COPC _E Concentrations in sediment (mg/kg dw)	Toxicity reference values for sediment (mg/kg dw)	
		Comparisons of COPC _E concentrations in sediment porewater to literature-based effects levels	COPC _E concentrations in porewater (µg/L)	Toxicity reference values for estuarine and marine waters (µg/L)	Porewater concentrations are modeled using sediment concentrations and Kd or Koc values from the literature (Table 4-5)
Bivalve Molluscs	Stable or increasing populations of bivalves within the site	Comparisons of COPC _E concentrations in clam tissue to literature-based reproductive effect values for molluscs	COPC _E concentrations in clam tissue	Toxicity reference values for invertebrate tissue (ng/kg ww)	
Fish	Stable or increasing populations of fish in the following guilds: benthic omnivore, benthic invertivore, benthic piscivore	Comparison of COPC _E concentrations in surface water to literature-based effects levels	COPC _E concentrations in water (µg/L)	Toxicity reference values for estuarine and marine surface waters (µg/L)	Surface water concentrations of nickel and BEHP are modeled using sediment concentrations and Kd or Koc values from the literature (Table 4-5)
		Comparison of COPC _E concentrations (metals) in the diet of fish to literature-based effects levels associated with concentrations in the diet of fish	COPC _E concentrations (metals) in food items of fish (mg/kg dw)	Toxicity reference values for concentrations of COPC _E s (metals) in food items of fish (mg/kg dw)	
		Comparisons of COPC _E concentrations (PCBs, dioxins, and furans) in fish tissue to literature-based effects levels	COPC _E concentrations (PCBs, dioxins, and furans) in fish tissue (µg/kg lw or ww)	Toxicity reference values for concentrations of COPC _E s (PCBs, dioxins, and furans) in fish tissue (ug/kg lw or ww)	
Reptiles	Stable or increasing populations of omnivorous reptiles	Comparison of estimated ingested COPC _E dose to literature-based effects levels expressed on a dose basis	COPC _E doses that account for all ingested media (mg/kg bw-day)	Toxicity reference values for concentrations of COPCEs as ingested doses (mg/kg bw-day)	
Birds	Stable or increasing populations of birds that may be exposed to COPC _E s from the site in the following feeding guilds: invertivore (aquatic and terrestrial), omnivorous wading bird, piscivorous diving bird	Comparison of estimated ingested COPC _E dose to literature-based effects levels expressed on a dose basis	COPC _E doses that account for all ingested media (mg/kg bw-day)	Toxicity reference values for concentrations of COPCEs as ingested doses (mg/kg bw-day)	
		Comparison of estimated concentrations of COPC _E s (dioxins and furans) in bird eggs to literature-based effects levels for associated with reproductive effects in birds	COPC _E (dioxins and furans) concentration in bird eggs (ng/g ww)	Toxicity reference values for COPC _E s (dioxins and furans) in bird eggs (ng/g ww)	Exposure concentrations are estimated using data for concentrations of COPC _E s in ingested media (prey and sediment)
Mammals	Stable or increasing populations of omnivorous mammals	Comparison of estimated ingested COPC _E dose to literature-based effects levels expressed on a dose basis	COPC _E doses that account for all ingested media (mg/kg bw-day)	Toxicity reference values for concentrations of COPCEs as ingested doses (mg/kg bw-day)	

Notes
bw = body weight
COPC_E = chemical of potential ecological concern
dw = dry weight

Modified from: Integral Consulting Inc. 2013. Baseline Ecological Risk Assessment, San Jacinto River Waste Pits Superfund Site. Prepared for: McGinnes Industrial Maintenance Corporation, International Paper Company, and U.S. Environmental Protection Agency, Region 6. May.

Table 26
Summary of Lines of Evidence for Ecological Receptors and Assessment Endpoints for the Area South of I-10

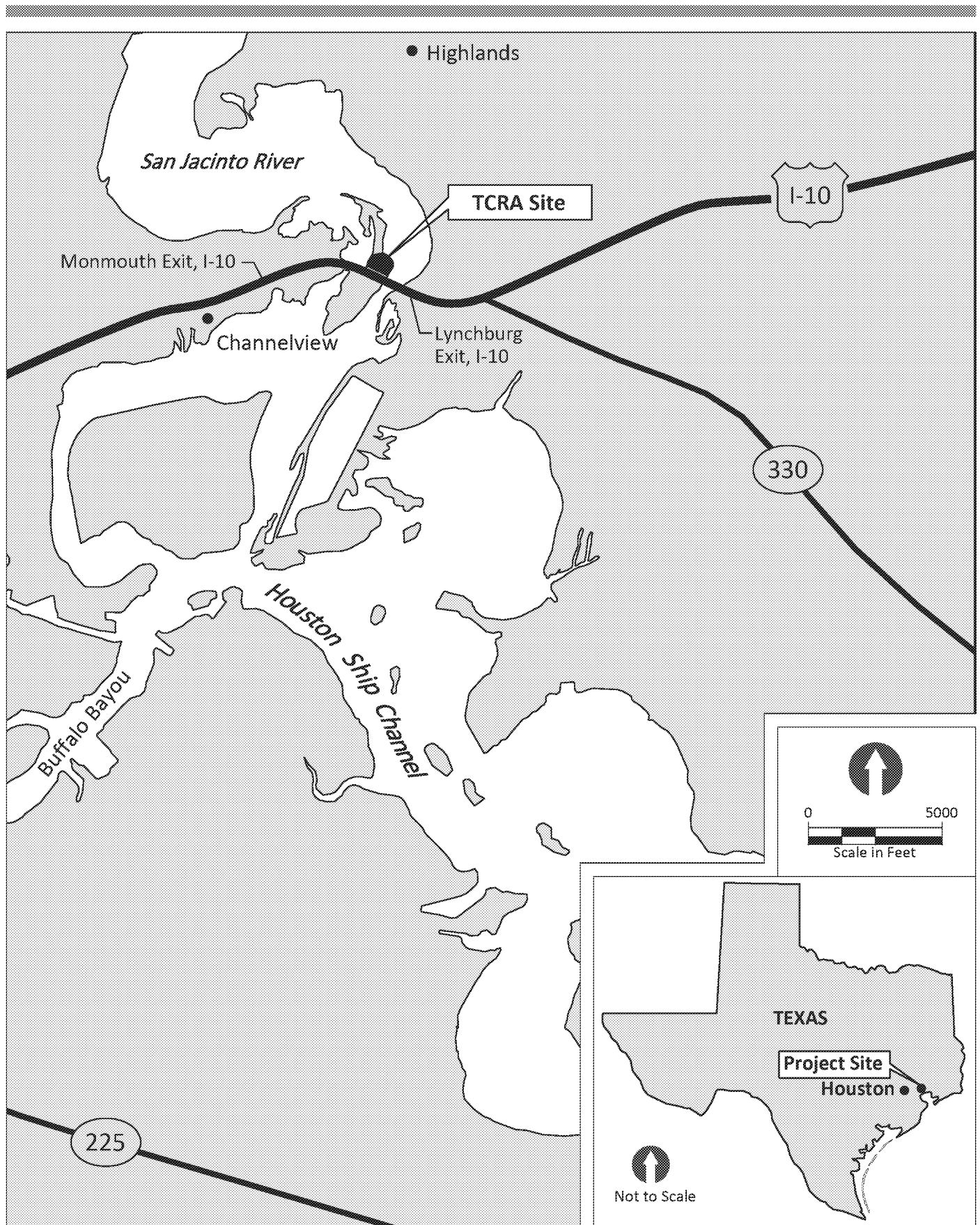
Receptor	Assessment Endpoint	Lines of Evidence	Measure of Exposure	Measure of Effect	Comments/Rationale
Reptiles	Stable or increasing populations of reptiles	Comparison of estimated ingested COPC _E dose to literature-based effects levels expressed on a dose basis	COPC _E doses that account for all ingested media (mg/kg bw-day)	Toxicity reference values for concentrations of COPC _E s as ingested doses (mg/kg bw-day)	Evaluated in the uncertainty assessment because dosimetric data for reptiles is lacking. Bird receptor is used as surrogate.
Birds	Stable or increasing populations of invertivorous birds	Comparison of estimated ingested COPC _E dose to literature-based effects levels expressed on a dose basis	COPC _E doses that account for all ingested media (mg/kg bw-day)	Toxicity reference values for concentrations of COPC _E s as ingested doses (mg/kg bw-day)	
Mammals	Stable or increasing populations of omnivorous mammals	Comparison of estimated ingested COPC _E dose to literature-based effects levels expressed on a dose basis	COPC _E doses that account for all ingested media (mg/kg bw-day)	Toxicity reference values for concentrations of COPC _E s as ingested doses (mg/kg bw-day)	
	Stable or increasing populations of herbivorous mammals	Comparison of estimated ingested COPC _E dose to literature-based effects levels expressed on a dose basis	COPC _E doses that account for all ingested media (mg/kg bw-day)	Toxicity reference values for concentrations of COPC _E s as ingested doses (mg/kg bw-day)	

Notes

bw = body weight
COPC_E = chemical of potential ecological concern

Modified from: Integral Consulting Inc. and Anchor QEA, LLC. 2013. Remedial Investigation Report, San Jacinto River Waste Pits Superfund Site.
Prepared for: McGinnes Industrial Maintenance Corporation, International Paper Company, and U.S. Environmental Protection Agency, Region 6. May.

FIGURES



Modified from: Anchor QEA, LLC. 2014. Draft Final Interim Feasibility Study Report, San Jacinto Waste Pits Superfund Site. Prepared for: McGinnes Industrial Maintenance Corporation, International Paper Company, and U.S. Environmental Protection Agency, Region 6. March.

Figure 1
Site Location
San Jacinto River Waste Pits Site



- USEPA's Preliminary Site Perimeter
- Original 1966 Perimeter of the Impoundments North of I-10
- Approximate TCRA Footprint
- Soil Investigation Area 4

FEATURE SOURCES:
Aerial Imagery: 0.5-meter. Photo Date: 01/14/2009
Texas Strategic Mapping Program (StratMap), TNRS

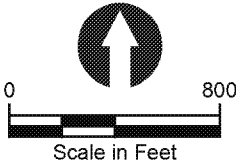


Figure 2
Site Overview
San Jacinto River Waste Pits Site

* Designation of the sand separation area is intended to be a general reference to areas in which such activities are believed to have taken place based on visual observations of aerial photography from 1998 through 2002.



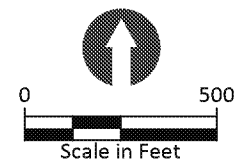
SOURCE: Google Map Pro 2009

NOTE: TCRA = Time Critical Removal Action

LEGEND:

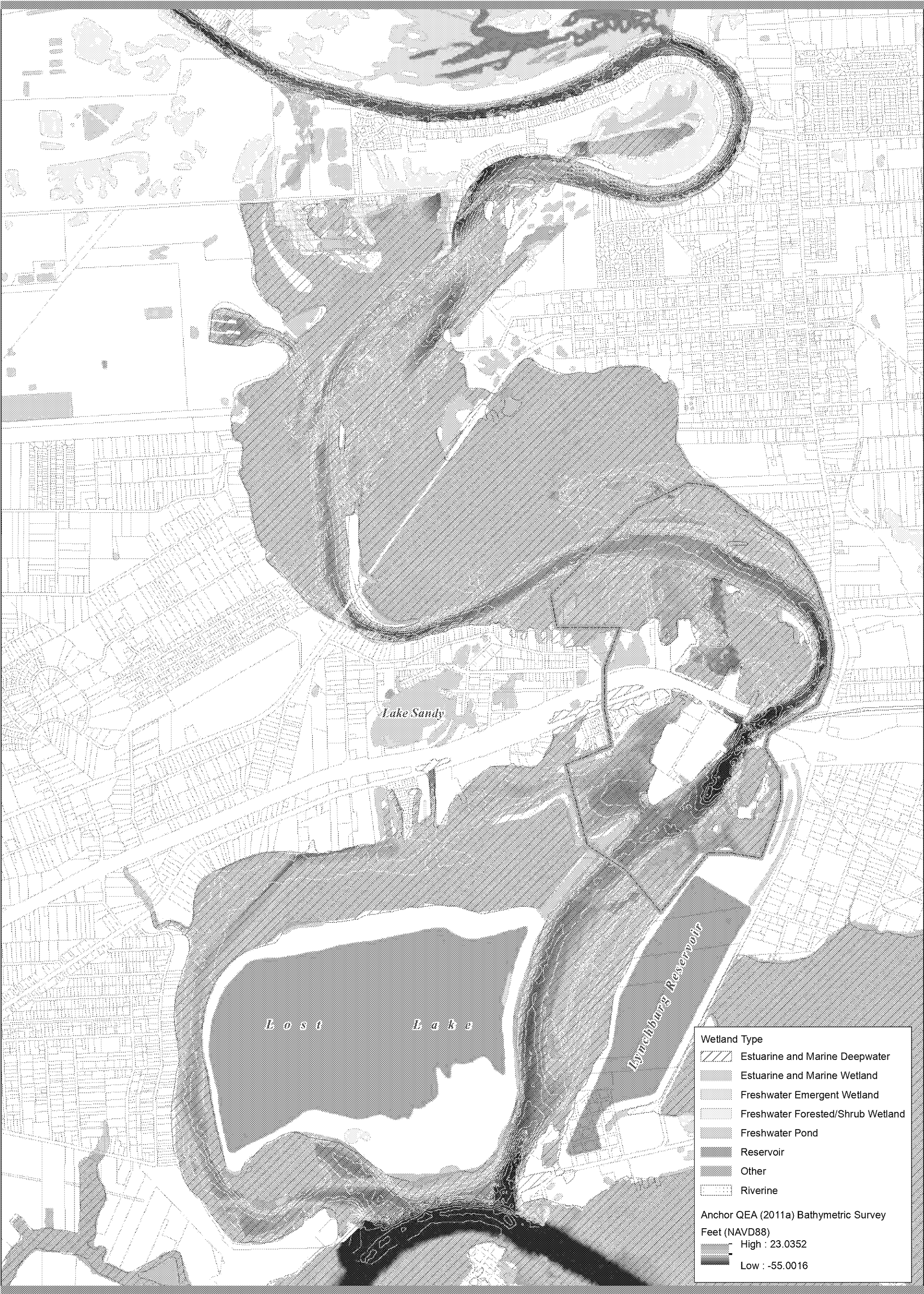
— — — Original 1966 Perimeter of the Impoundments North of I-10

Approximate TRCA Footprint



Modified from: Integral Consulting Inc. and Anchor QEA, LLC. 2013. Remedial Investigation Report, San Jacinto River Waste Pits Superfund Site. Prepared for: McGinnes Industrial Maintenance Corporation, International Paper Company, and U.S. Environmental Protection Agency, Region 6. May.

Figure 3
Time Critical Removal Action Vicinity Map
San Jacinto River Waste Pits Site



USEPA's Preliminary Site Perimeter
1-Meter 1995 Bathymetric Contour
Parcel Boundary

FEATURE SOURCES:
Bathymetry and Contours: Anchor QEA (2011a)
Wetlands: U.S. Fish and Wildlife Service.
Parcel Boundaries: Harris County Appraisal District.

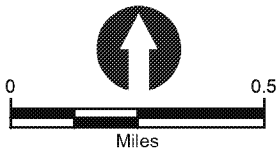
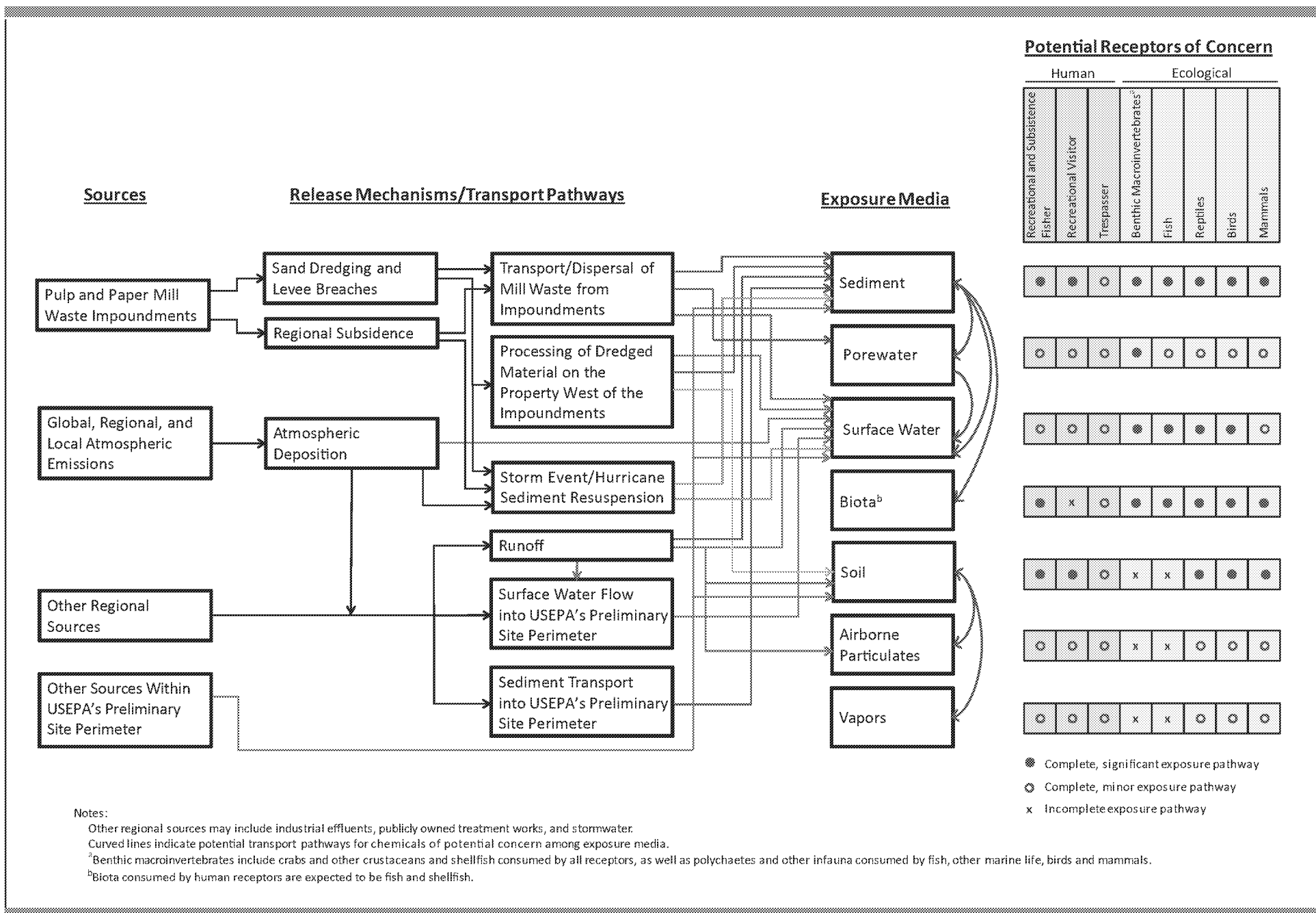


Figure 4
Habitats in the Vicinity of the Site
San Jacinto River Waste Pits Site

Modified from: Integral Consulting Inc. and Anchor QEA, LLC. 2013. Remedial Investigation Report, San Jacinto River Waste Pits Superfund Site. Prepared for: McGinnes Industrial Maintenance Corporation, International Paper Company, and U.S. Environmental Protection Agency, Region 6. May.



Modified from: Integral Consulting Inc. and Anchor QEA, LLC. 2013. Baseline Human Health Risk Assessment, San Jacinto River Waste Pits Superfund Site. Prepared for: McGinnes Industrial Maintenance Corporation, International Paper Company, and U.S. Environmental Protection Agency, Region 6. May.

Figure 5
Conceptual Site Model Pathways for the Area North of I-10 and Aquatic Environment
San Jacinto Waste Pits Site

<u>Exposure Media</u>	<u>Exposure Route</u>	<u>Potential Human Receptors of Concern</u>		
		Recreational and Subsistence Fishers	Recreational Visitor	Trespasser
Sediment	Ingestion	●	●	○
	Dermal Contact	●	●	○
Porewater	Dermal Contact	○	○	○
Surface Water	Ingestion	○	○	○
	Dermal Contact	○	○	○
Fish and Shellfish	Ingestion	●	x	○
Soil	Ingestion	●	●	○
	Dermal Contact	●	●	○
Airborne Particulates	Inhalation	○	○	○
Vapors	Inhalation	○	○	○

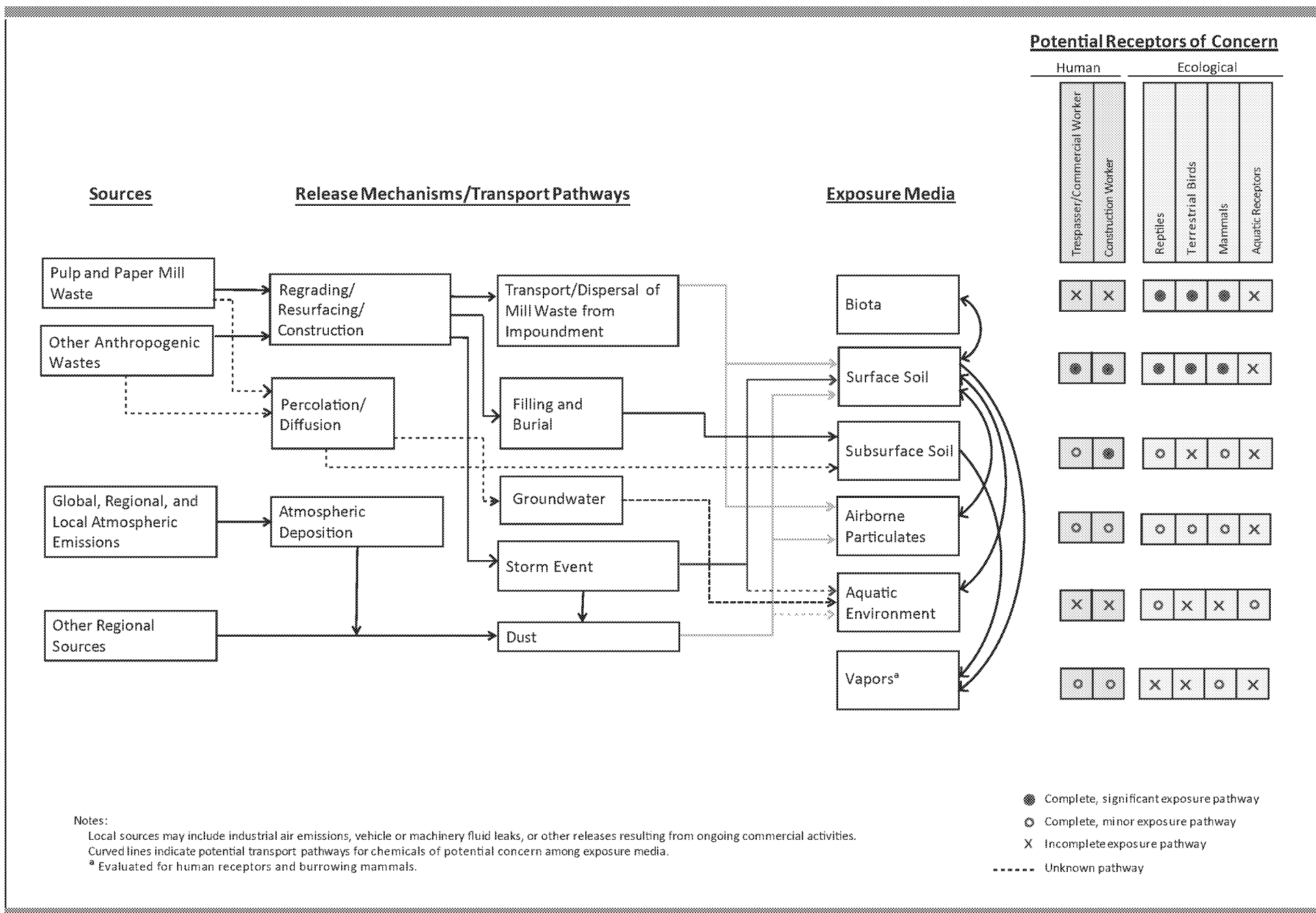
● Potentially complete and significant exposure pathway

○ Potentially complete but minor exposure pathway

x Incomplete exposure pathway

Modified from: Integral Consulting Inc. and Anchor QEA, LLC. 2013. Baseline Human Health Risk Assessment, San Jacinto River Waste Pits Superfund Site. Prepared for: McGinnes Industrial Maintenance Corporation, International Paper Company, and U.S. Environmental Protection Agency, Region 6. May.

Figure 6
Human Exposure Pathways for the Area North of I-10 and Aquatic Environment
San Jacinto River Waste Pits Site



Modified from: Integral Consulting Inc. and Anchor QEA, LLC. 2013. Baseline Human Health Risk Assessment, San Jacinto River Waste Pits Superfund Site. Prepared for: McGinnes Industrial Maintenance Corporation, International Paper Company, and U.S. Environmental Protection Agency, Region 6. May.

Figure 7
Conceptual Site Model Pathways for the Area South of I-10
San Jacinto River Waste Pits Site

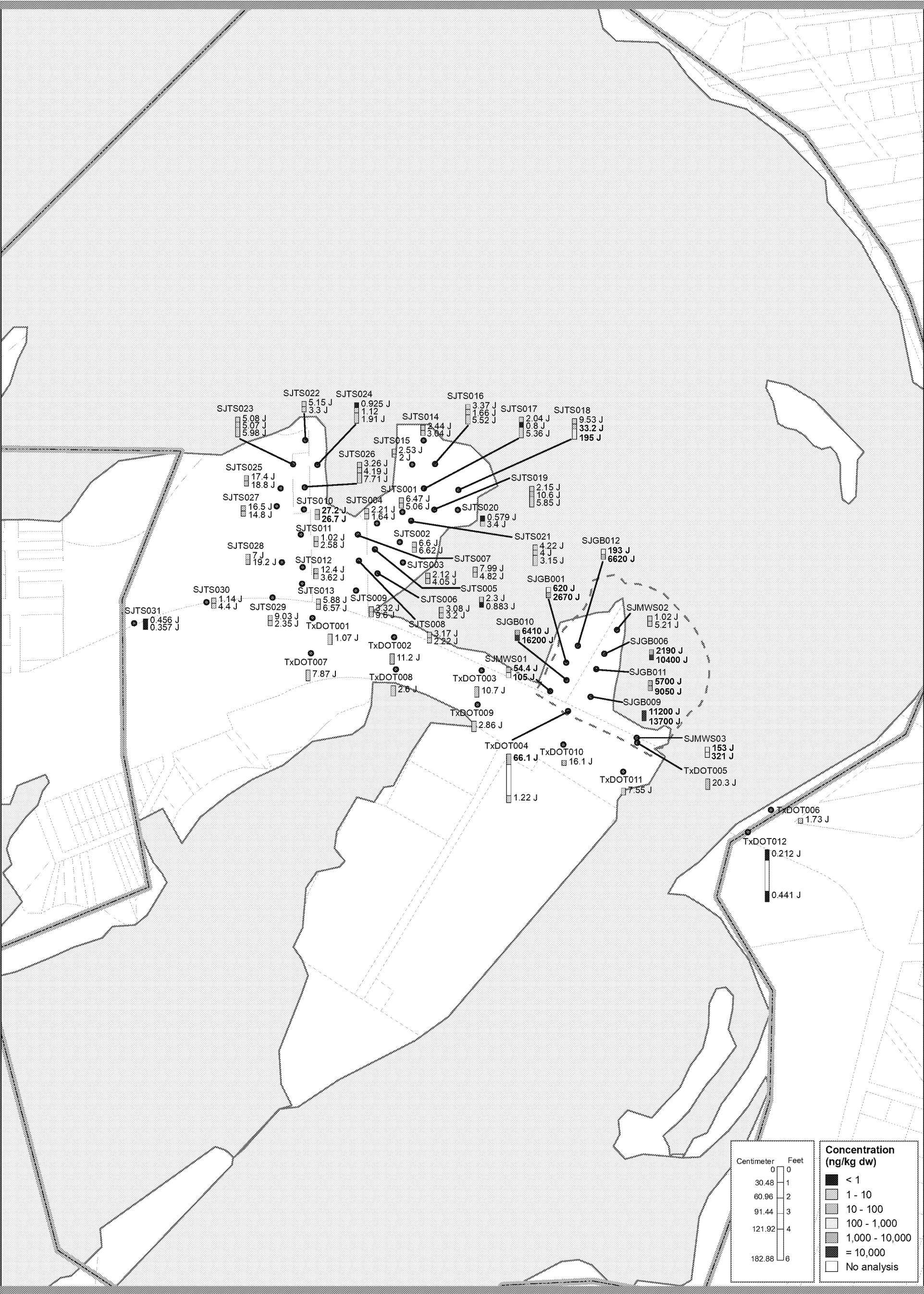
<u>Exposure Media</u>	<u>Exposure Route</u>	<u>Potential Human Receptors of Concern</u>	
		<u>Trespasser/ Commercial Worker</u>	<u>Construction Worker</u>
Soil	Ingestion	●	●
	Dermal contact	●	●
Subsurface Soil	Ingestion	X	●
	Dermal contact	X	●
Airborne Particulates and Vapors	Inhalation	○	○

Notes:

- Potentially complete and significant exposure pathway
- Potentially complete but minor exposure pathway
- X Incomplete exposure pathway

Modified from: Integral Consulting Inc. and Anchor QEA, LLC. 2013. Baseline Human Health Risk Assessment, San Jacinto River Waste Pits Superfund Site. Prepared for: McGinnes Industrial Maintenance Corporation, International Paper Company, and U.S. Environmental Protection Agency, Region 6. May.

Figure 8
Human Exposure Pathways for the Area South of I-10
San Jacinto River Waste Pits Site



- Soil Sampling Location
- ▭ USEPA's Preliminary Site Perimeter
- ▭ Original 1966 Perimeter of the Impoundments North of I-10

Notes:
TEQ_{DF,M} = toxicity equivalent for dioxins and furans using mammalian TEFs from van den Berg et al. (2006) (nondetect = 1/2 detection limit)

J = Estimated. One or more congeners used to calculate the TEQ_{DF,M} was not detected.

Concentrations in bold indicate values above reference envelope value (REV) for surface soil; REV = 24.3 ng/kg dw

FEATURE SOURCES:
Parcel Boundaries: Harris County Appraisal District

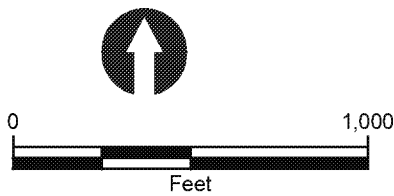


Figure 9
Distribution of TEQ_{DF} in Soils
of the TxDOT Right-of-Way and North of I-10
San Jacinto River Waste Pits Site

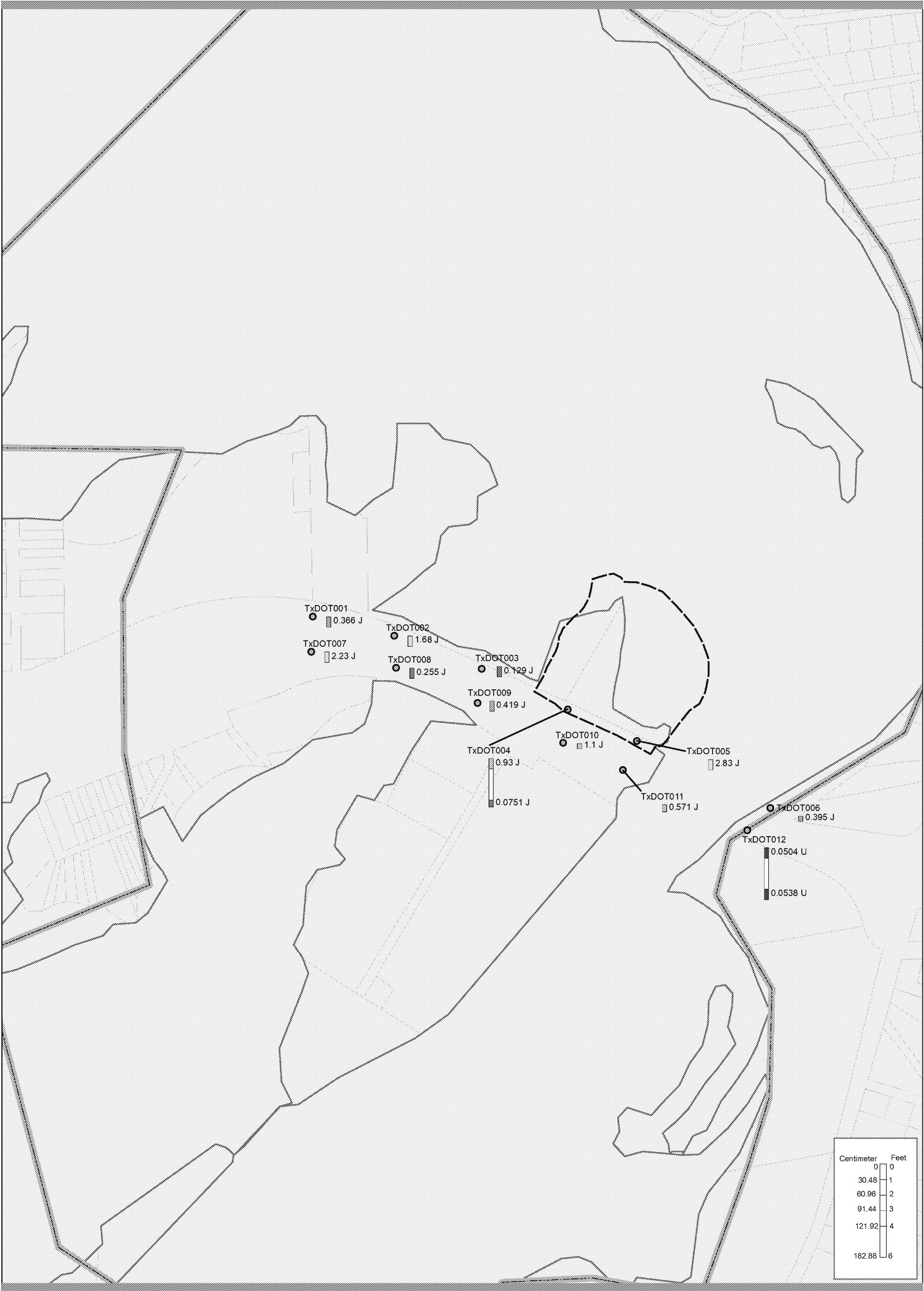
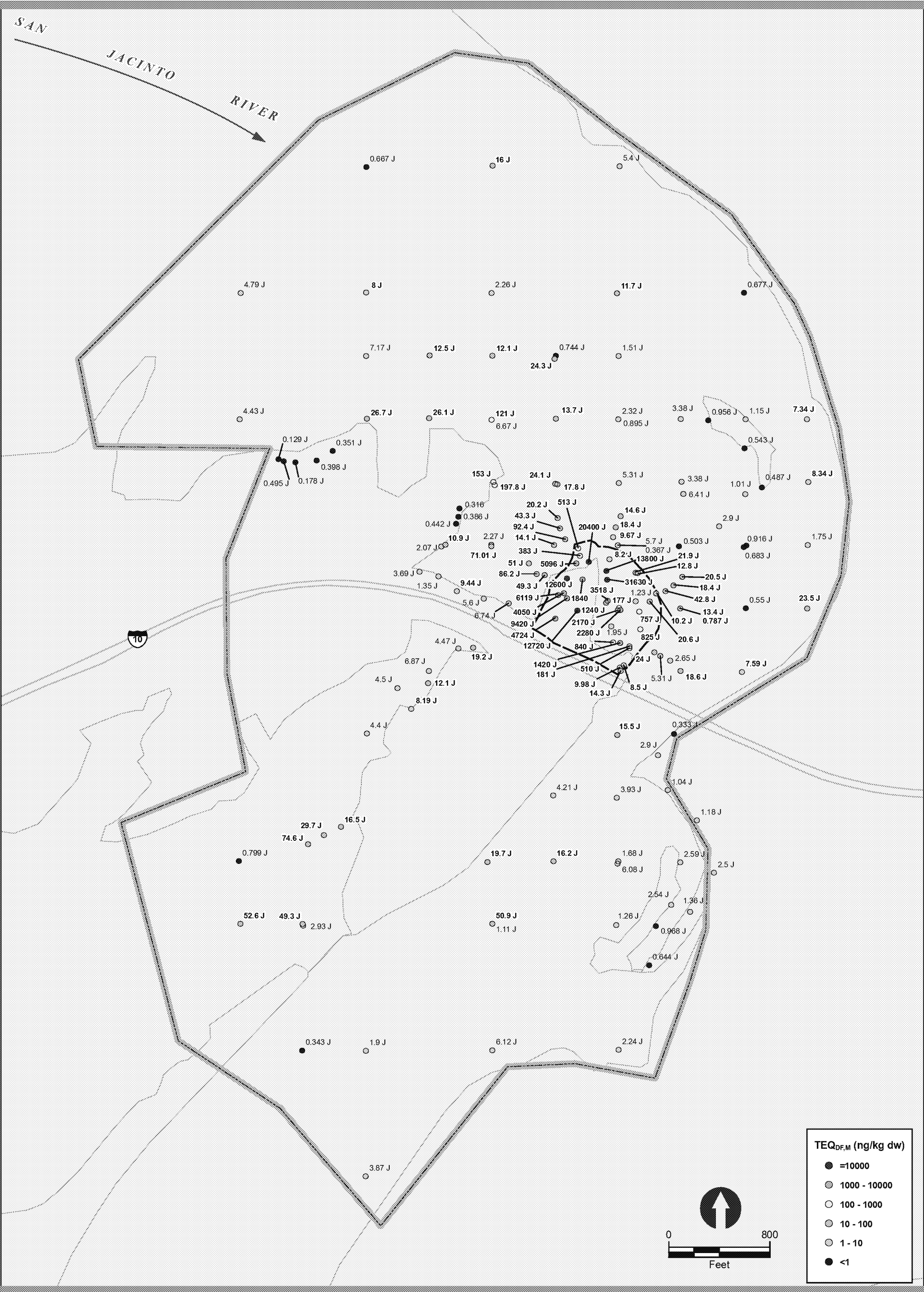


Figure 10
Distribution of TEQ_{P,M} (ND = 1/2 DL)
in Soils of the TxDOT Right-of-Way
San Jacinto River Waste Pits Site

NOTES:
TEQ_{P,M} = Toxicity equivalent for 2,3,7,8-TCDD calculated for dioxin-like PCBs using mammalian TEFs from van den Berg et al.(2006) (nondetect = 1/2 detection limit)
J = Estimated. One or more congeners used to calculate the TEQ_{P,M} was not detected.
U = Undetected at the detection limit shown.



USEPA's Preliminary Site Perimeter
Original 1966 Perimeter of the Impoundments North of I-10
Surface Sediment Sample Location

Notes:
TEQ_{DF,M} = Toxicity equivalent for 2,3,7,8-TCDD calculated for dioxins and furans using mammalian TEFs from van den Berg et al. (2006) (nondetect = 1/2 detection limit)
J = Estimated. One or more congeners used to calculate the TEQ_{DF,M} was not detected.
Concentrations in bold indicate values above reference envelope value (REV); REV = 7.2 ng/kg dw

Figure 11
TEQ_{DF} Concentrations in Surface Sediment & Waste
San Jacinto River Waste Pits Site

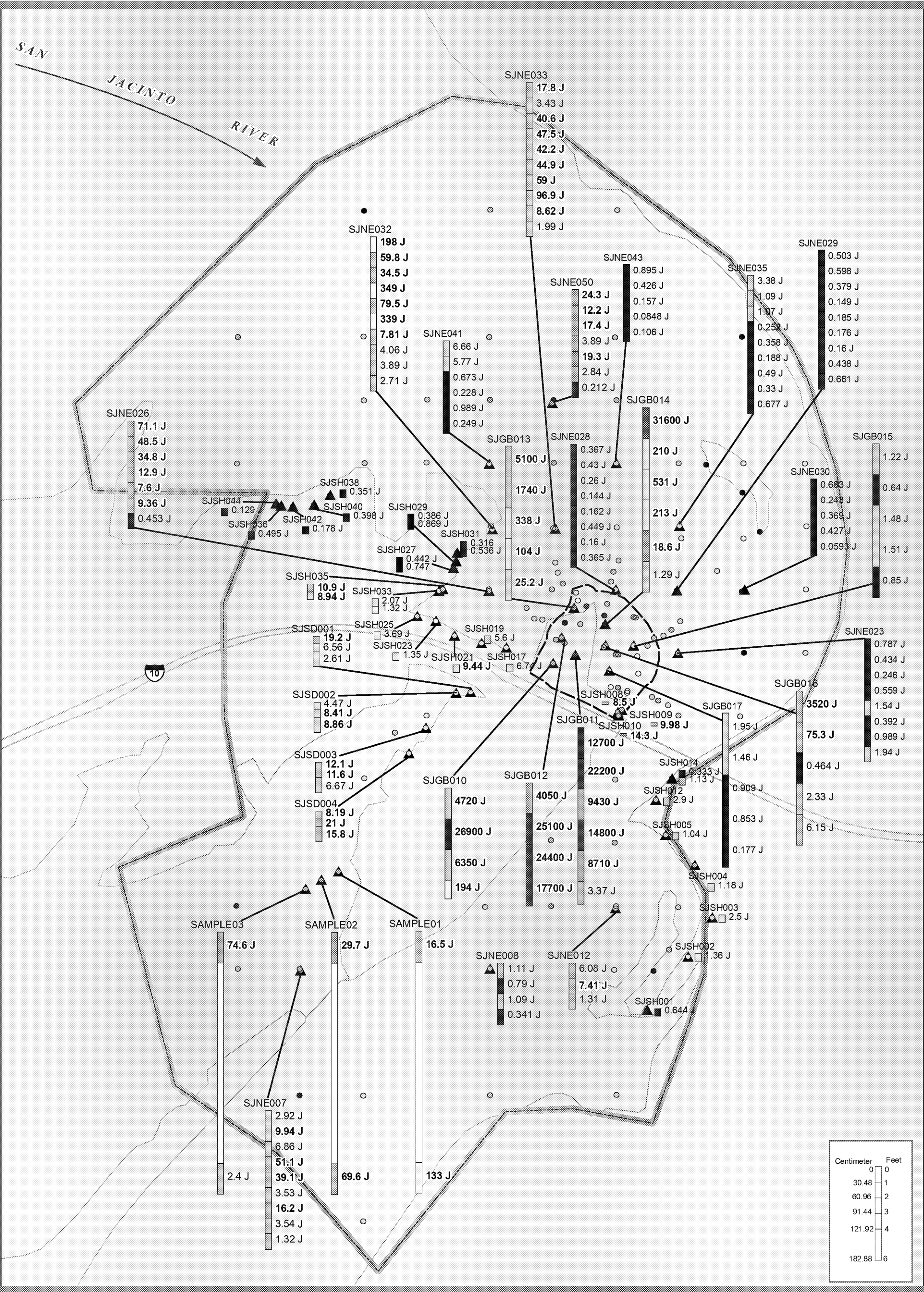


Figure 12
TEQ_{DF} Concentrations in Sediment & Waste Cores
San Jacinto River Waste Pits Site

USEPA's Preliminary Site Perimeter
Original 1966 Perimeter of the Impoundments North of I-10

Notes:
TEQ_{DFM} = Toxicity equivalent for 2,3,7,8-TCDD calculated for dioxins and furans using mammalian TEFs from van den Berg et al. (2006) (nondetect = 1/2 detection limit)
J = Estimated. One or more congeners used to calculate the TEQ_{DFM} was not detected.
Concentrations in bold indicate values above reference envelope value (REV); REV= 7.2 ng/kg dw

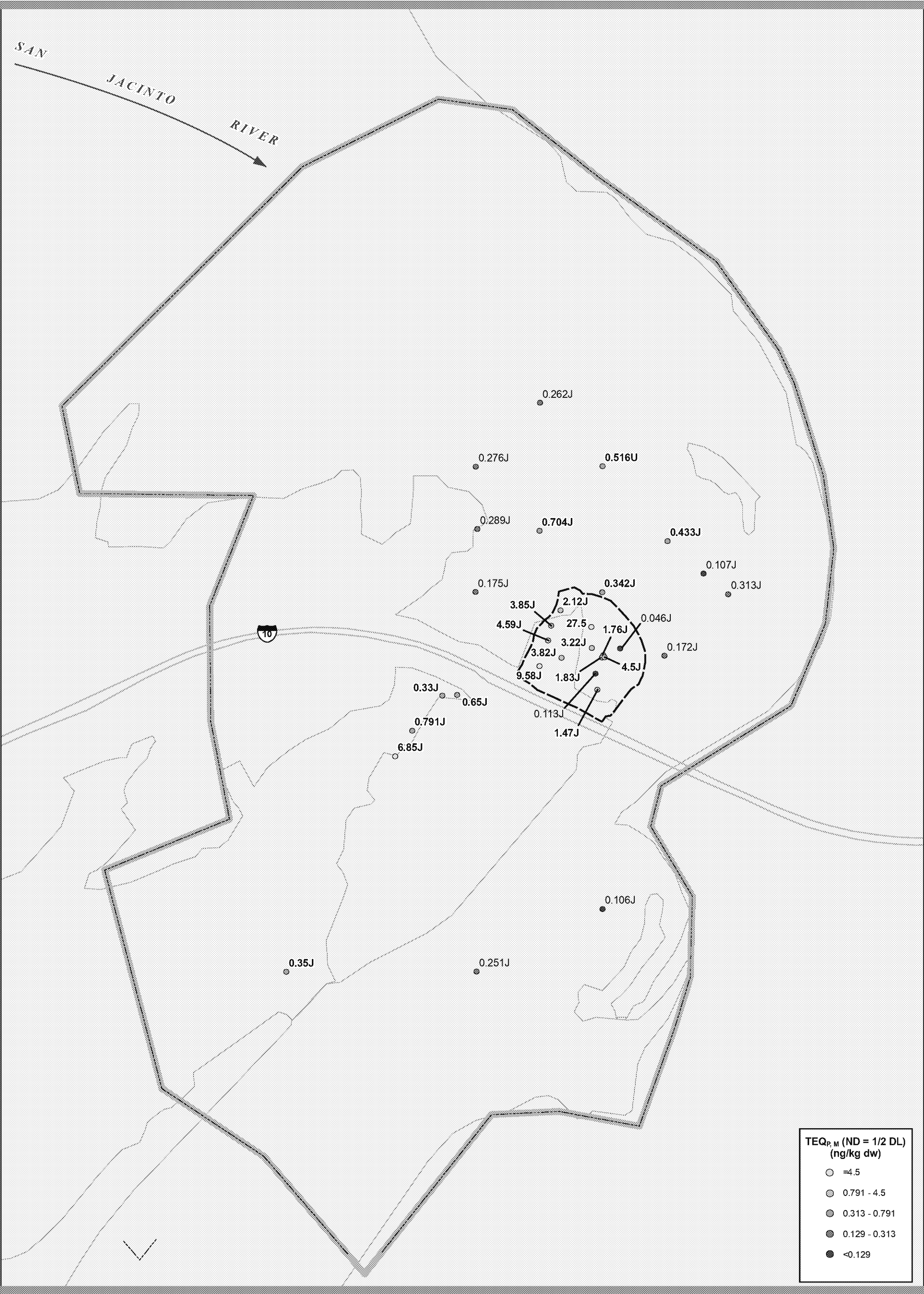
Core Location
Surface Sediment Sample Location

TEQ_{DFM} (ng/kg dw)
Cores
=10000
1000 - 10000
100 - 1000
10 - 100
1 - 10
<1
No analysis

0 800
Scale in Feet

Centimeter Feet
0 0
30.48 1
60.96 2
91.44 3
121.92 4
182.88 6

Modified from: Integral Consulting Inc. and Anchor QEA, LLC. 2013. Remedial Investigation Report, San Jacinto River Waste Pits Superfund Site.
Prepared for: McGinnes Industrial Maintenance Corporation, International Paper Company, and U.S. Environmental Protection Agency, Region 6. May.



USEPA's Preliminary Site Perimeter
Original 1966 Perimeter of the Impoundments North of I-10

Notes:

TEQ_{p,m} = Toxicity equivalent for 2,3,7,8-TCDD calculated for dioxin-like PCBs using the toxicity factor for mammals using van den Berg et al. (2006) (nondetect = 1/2 detection limit)

J = Estimated.
U = Undetected at detection limit shown.

Concentrations in bold indicate values above reference envelope value (REV); REV = 0.326 ng/kg dw

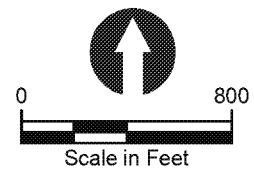
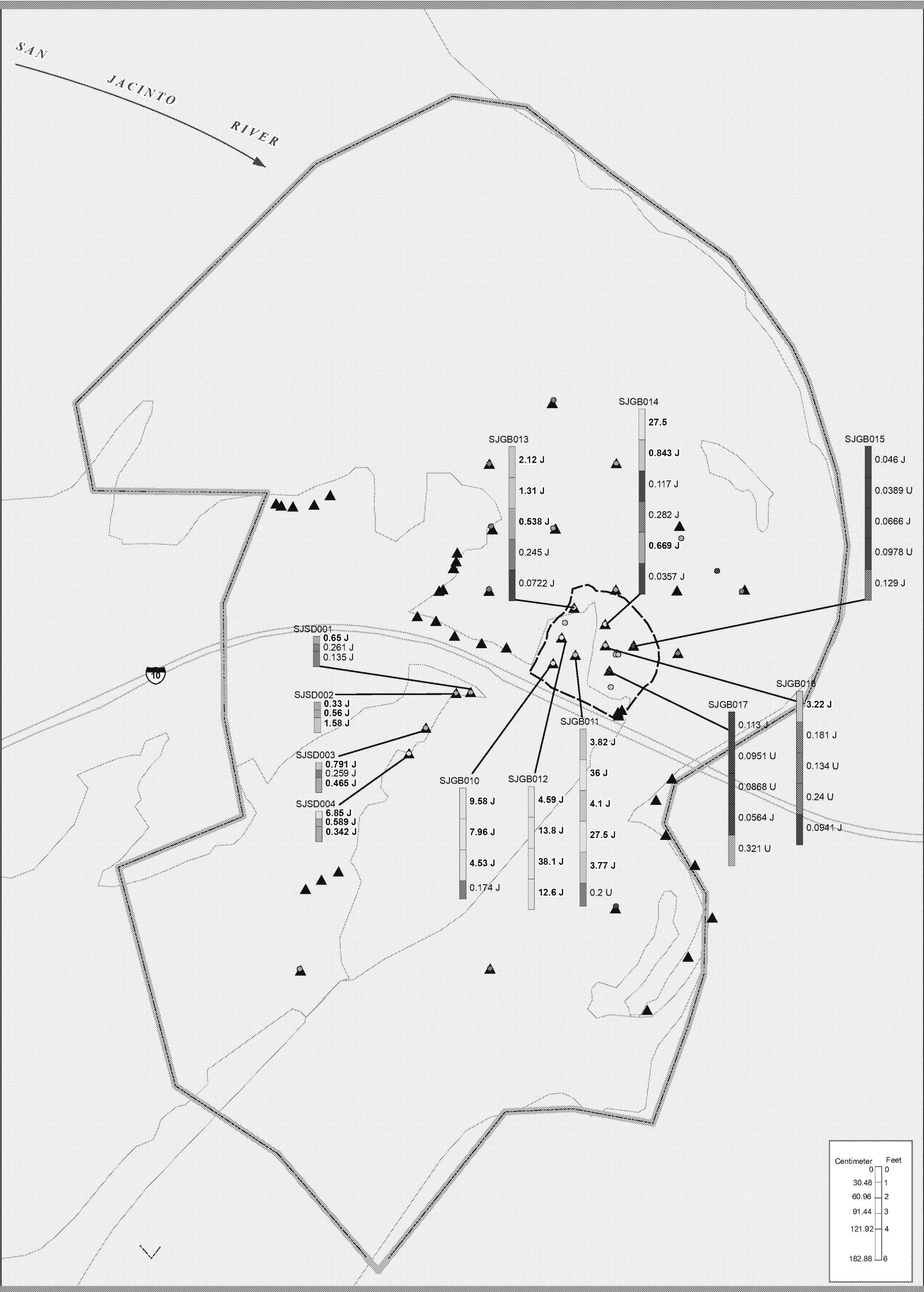


Figure 13
TEQ_{p,m} (ND = 1/2 DL) Concentrations in Surface Sediment & Waste San Jacinto River Waste Pits Site



USEPA's Preliminary Site Perimeter

Original 1966 Perimeter of the Impoundments North of I-10

Notes:

TEQ_{P,M} = Toxicity equivalent for 2,3,7,8-TCDD calculated for dioxin-like PCBs using the toxicity factor for mammals using van den Berg et al. (2006) (nondetect = 1/2 detection limit)

J = Estimated.

U = Undetected at detection limit shown.

Concentrations in bold indicate values above reference envelope value (REV); REV = 0.326 ng/kg dw

TEQ_{P,M} (ND = 1/2 DL)
(ng/kg dw)
Cores

	≈4.5
	0.791- 4.5
	0.313 - 0.791
	0.129 - 0.313
	<0.129

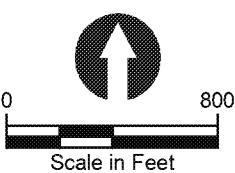


Figure 14
TEQ_{P,M} (ND = 1/2 DL) Concentrations
in Sediment & Waste Cores
San Jacinto River Waste Pits Site

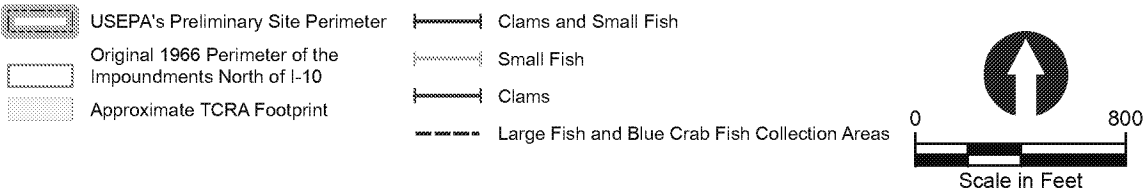


Figure 15
Fish Collection Areas and Tissue Sampling Transects
San Jacinto River Waste Pits Site

⁹ Designation of the sand separation area is intended to be a general reference to areas in which such activities are believed to have taken place based on visual observations of aerial photography from 1998 through 2002.

FEATURE SOURCES:
Aerial Imagery: 0.5-meter January 2009 DOQQs - Texas Strategic Mapping Program (StratMap), TNIS

Modified from: Integral Consulting Inc. and Anchor QEA, LLC. 2013. Remedial Investigation Report, San Jacinto River Waste Pits Superfund Site.
Prepared for: McGinnes Industrial Maintenance Corporation, International Paper Company, and U.S. Environmental Protection Agency, Region 6. May.

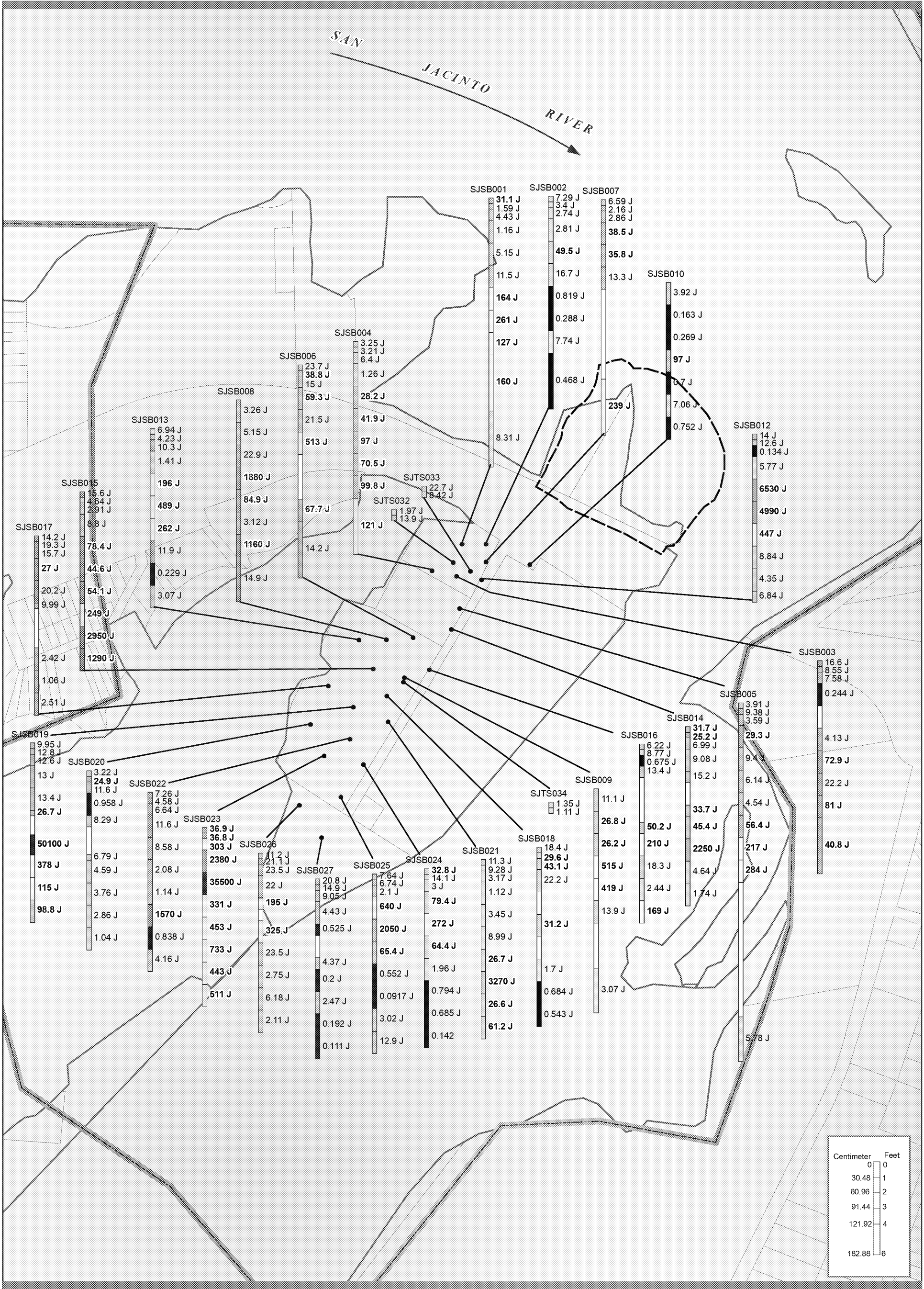
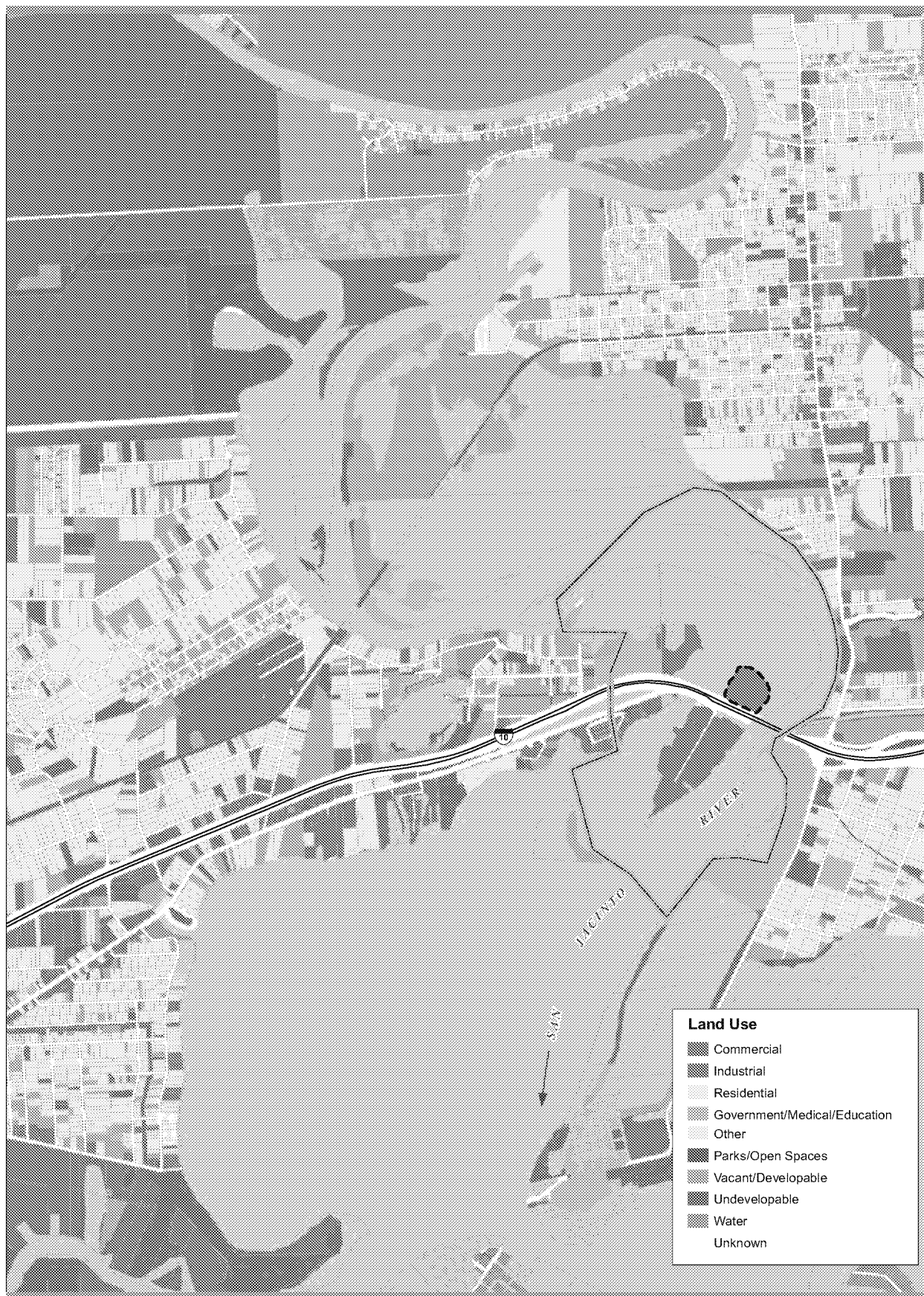


Figure 16
Distribution of TEQ_{DF} in Soil Investigation Area 4
and Adjacent Soils
San Jacinto River Waste Pits Site



USEPA's Preliminary Site Perimeter
 Limit of TCRA Cap
 Tax Parcel Boundary

FEATURE SOURCES:
 Land Use: Modified from Houston-Galveston Area Council*
 Parcel Boundaries: Harris County Appraisal District

*Modifications to land use within USEPA's Preliminary Site Perimeter to show reasonably anticipated future land use where appropriate.

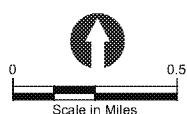


Figure 17
 Land Use in the Vicinity of the Site
 San Jacinto River Waste Pits Site